NASA Press Release #-1

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

1512 H Street, N.W. Washington 25, D.C.

FOR RELEASE:
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SEPTEMBER 26, 1958

NASA to Take Over NACA September 30

Work on plans and programs of the National Aeronautics and Space Administration has progressed to the point where the new space agency will absorb the personnel, facilities and research activities of the 43-year-old National Advisory Committee for Aeronautics at the close of business September 30, T. Keith Glennan, NASA Administrator, who is on leave as president of Case Institute of Technology, announced today. With this action, NASA will be effectively "in business".

The action will come nearly a month sooner than the statutory requirement that the transfer, by proclamation in the Federal Register, be made not later than 90 days after the date of enactment of the Space Act (President Eisenhower signed it July 29). Glennan said he would soon announce details of the NASA organizational structure.

In a message to NACA employes about the impending transfer he said in part:

"One way of saying what will happen would be to quote from the legalistic language of the Space Act: 'The NACA shall cease to exist... (and) all function, powers, duties and obligations and all real and personal property, personnel (other than members of the Committee), funds, and records of that organization' shall be transferred to NASA.

"My preference is to state it in a quite different way... that what will happen September 30 is a sign of metamorphosis... it is an indication of the changes that will occur as we develop our capacity to handle the bigger job that is ahead... We have one of the most challenging assignments that has ever been given to modern man."

Glennan said the three main NACA laboratories will be renamed in the changeover to NASA. The Langley Aeronautical Laobratory at Langley Field, Virginia, will be renamed the Langley Research Center. The name of Ames Aeronautical Laboratory, Moffett Field, California, will be changed to Ames Research Center, and the Lewis Flight Propulsion Laboratory, in Cleveland, Ohio, to the Lewis Research Center. No change of name is pending for the High Speed Flight Station, Edwards, California; Pilotless Aircraft Research Station, Wallops Island, Virginia, or the Plum Brook Research Reactor Facility, Sandusky, Ohio. NASA takes over NACA Headquarters in Washington.

At the same time, the 28 committees and subcommittees under the National Advisory Committee for Aeronautics will be reconstituted as advisory committees to the Administration until the end of this year, for the purpose of completing their work. Existing policies, regulations and similar matters governing NACA activities are to be continued in effect by the Administrator until changed or abolished.

The NACA staff now numbers more than 8000 scientists, engineers, technicians and other employes. Its laboratory facilities are valued in excess of $300,000,000.

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"The National Aeronautics and Space Administration"

by Hugh L. Dryden, Deputy Administrator

for presentation to

The Air Force Association

September 26, 1958
Dallas, Texas

On August 19, T. Keith Glennan, for the past 11 years president of the Case Institute of Technology, and I were sworn in as Administrator and Deputy Administrator, respectively, of the National Aeronautics and Space Administration. In the days since then, I can assure you, a very great deal has happened, even though -- as in the case of the proverbial iceberg -- most of what has taken place has not been apparent to the onlooker.

So much has happened, in fact, that Dr. Glennan has already announced he will proclaim, in accordance with the terms of the National Aeronautics and Space Act of 1958, that by the close of business September 30, the NASA will have been organized and will be prepared to discharge the duties and exercise the powers conferred upon it by the Act. On or about that date, it may be expected he will make appropriate announcements respecting the organization of the Space Agency and detail its plans and programs.

Today, rather than seek to anticipate these announcements, I propose to discuss some aspects of the task the President and the Congress have assigned to the NASA. After I have finished, perhaps you will agree that there may have been some significance, at least symbolically, in the recent move of our headquarters in Washington to the premises occupied for many years by the Cosmos Club.

The Space Act of 1958 plainly states the policy of the United States to be, quote, "activities in space should be devoted to peaceful purposes for the benefit of all mankind." Repeatedly, the President has expressed his earnest wishes in similar vein, and only last week, the Honorable John Foster Dulles, Secretary of State, said in an address to the United Nations General Assembly, "We must make every effort exclusively to the constructive pursuits of mankind." He then called upon the United Nations to, "take immediate steps to prepare for a fruitful program of international cooperation in the peaceful uses of outer space."

As Americans, we can be rightly proud that our country is leading -- has, in fact, led for nearly a year -- in the effort to establish a workable system that will give meaning to the principle that space flight is, or at least should be, inherently international.

In this connection there can be no quarrel with the idea that use of space as may be required for national defense should be the responsibility of the Department of Defense. The Space Act makes such assignment, stipulating as of proper military concern, quote, "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the Defense of the United States)."

There will be areas of space activity where there will be a duality of interest. The Select Committee on Astronautics and Space Exploration of the House, in its report of May 20, recognized this fact, and then commented:

"Although weather and communications satellites, manned platforms, and the like have obvious military uses, their primary purpose should be declared civilian. If we do not do this, we automatically commit the world of the future to the same stalemated life in armor which is lived by the world of today. If the very efficiency of current weapons virtually denies the practicable possibility of total war, further strides made in our rocket development would probably intensify this denial... The entire purpose of our effort should be to insure that the peaceful uses of these devices prevail. This is the stated philosophy behind our space exploration. It is the philosophy of this country."

Now, I must add that I am aware -- I could say, painfully aware -- of the belief stated in some quarters that unless there is a definite military potential to our work in space technology and space exploration, adequate financial support will not be forthcoming for long from future National Administrations and future Congresses. I am aware of the dangers of predicting what will happen in the future, but on the basis of what we already know, I think that in a relatively short time the economic payoffs of our civilian space effort will have been so large as to make the entire space effort fully self-financing.

Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory, is on record as saying that space technology will permit weather forecasting to "become a science instead of an art", and that the value of this revolution in meteorology, "will greatly out-weigh the cost of the entire program." Similarly, Dr. Francis W. Reichelderfer, Chief of the Weather Bureau, estimates the value of the more accurate, longer range weather forcasting and storm warnings that we can expect to attain from good use of space technology will be several billion dollars a year.

Similarly, Dr. Wernher von Braun, director of the Development Operations Division of ABMA at Huntsville, Alabama, estimates that, using man-made satellites to transmit commecial messages and TV programs on a global basis will not only be commercially practicable but will, quote, "pay for trips to the moon and other ventures in this business."

In my personal opinion, it is factually incorrect to state that the only proper justification for supporting work in space is military. Plainly, it is a perversion of the facts to suggest that all non-military space activity should be considered mere "fun in space".

Fortunately, determination of our national space policies will be established at the highest level. To insure this, the Congress wrote into the Space Act a National Aeronautics and Space Council and further that the President himself should preside over its meetings. The organization meeting of the Council was held earlier this week.

Sometimes, the best way to obtain a good understanding of the real meaning of a piece of legislation is to refer to such Congressional publications as a Conference Report. Such a report was written after Senate and House conferees had resolved differences over the language and terms of the Space Act.

Let me quote a few sentences from that Report: ". . . the function of the Council is to advise the President in the performance of the following duties: to survey all significant aeronautical and space activities, including those of the United States Government; to develop a comprehensive program of such activities to be carried out by the United States Government; and to allocate responsibility for major aeronautical and space activities and provide for effective cooperation and resolve differences among departments and agencies of the United States. These duties represent the most important single means for carrying out the purposes of the act. . ."
The composition of the Space Council includes the Secretary of State, Secretary of Defense, Administrator of NASA, and chairman of AEC, plus not more than one additional Government member, and not more than three additional members from private life. The President has therefore designated the Director of the National Science Foundation (Dr. Alan T. Waterman) from government, and, from private life, Jimmie Doolittle, Dr. Detlev W. Bronk of the National Academy of Sciences, and William A. M. Burden, long active in aeronautical matters. I am quite willing to look to such an eminent group as this for recommendations leading to the determination of the scope and direction of our national space programs.

I would, however, add the personal conviction that our planning for space must be with the awareness that sustained and intensive effort will be required for many years to come. Some of the projects not yet fairly underway -- such as development of rocket motors in the million-pound-thrust class -- will take as much as five years to complete. Still others, such as the electric propulsion systems that will be needed when we venture on really long voyages into space, may require ten or more years of effort.

We must plan long-range. We must be confident that long-term projects will receive long-term support. It would be tragic indeed if our national space programs were to be subjected to the uncertainties of a "blow hot, blow cold" kind of financing. This possibility, I believe, is most fortunately remote because of an awareness of how grave the urgency is for us to become and remain leaders in the exploration of space.

Now, I should like to discuss briefly the National Advisory Committee for Aeronautics vis-a-vis the National Aeronautics and Space Administration. For 11 years I was privileged to head the NACA staff. The work of the 8,000 scientists, engineers and other employes, seeking solutions to the problems of flight, represented one of the best returns ever made on the taxpayers' dollars. I am proud, and I believe my feeling is shared by all others of the organization, that the NACA was the choice of all other government agencies to serve as the nucleus of the NASA.

But make no mistake, the NASA is a new agency. It will be different from NACA in many ways. The vital functions of NACA, research into the problems of flight, will be continued and perhaps even intensified, but this activity will be only one part of NASA's programs. NASA will have to administer substantial programs of research, development and procurement, on a contract basis. It will be spending large amounts of money, outside the agency, by contracts with scientific and educational institutions, and with industry. It will be developing and launching into space, the vehicles needed to obtain scientific data and to explore the solar system. It will be preparing for the day, probably within a few years, when man himself ventures on voyages into space.

NASA will have to broaden and extend the excellent, teamwork relationships that NACA enjoyed over the years with the Military Services and with the airplane-missile-space industry. It will be using facilities of the Armed Forces, such as the launching pads at Cape Canaveral in Florida and Vandenberg Air Force Base in California. It will be expanding its own facilities at Wallops Island, on the Virginia Coast, to permit launching satellites up to, say, 100-pounds size. It will be operating satellite-tracking stations around the world. It will be collecting great masses of scientific data, and reducing them to useful form.

In summary, the scope of NASA's mission is in many, many ways different from that of NACA during its 43 years of fruitful life.

This week Dr. Glennan addressed a message to all NACA employes. Referring to the September 30 takeover date, he conceded that one way to describe what will happen would be to quote from the legalistic language of the Space Act: "The NACA shall cease to exist. . . (and) all functions, powers, duties and obligations and all real and personal property, personnel (other than members of the Committee), funds, and records of that organization" shall be transferred to NASA.

Then he continued, "My preference is to state it in a quite different way. I like to say, and I believe I am being very realistic and very accurate when I do, that what will happen September 30 is a sign of metamorphosis... an indication of the changes that will occur as we grow to where we can do the bigger job that is ahead."

Finally, because I am sure many of you here today are most eager to learn more about the Administrator of NASA, let me tell you a little about Keith Glennan. I have known him, not intimately, but from fairly frequent contacts, for the past 8 or 10 years. Our people at the Lewis Flight Propulsion Laboratory have known him for at least that long; he became president at Case in 1947. They have watched him direct the building of that institution until today it ranks among the best of our country's scientific schools. In Cleveland Keith Glennan has earned the respect and admiration of the community.

For the past several weeks he and I have worked together most closely. I can say he is not afraid of work, and that he expects his associates to be equally industrious. During the Senate confirmation hearings he was asked what he thought was called for in the job of NASA Administrator. I quote his answer, because I think it is typical of the man: "A great deal of energy, a lot of application and understanding... Application and understanding, I think, of the manner in which some of these things get done. It isn't just a matter of the money that is involved, but it is a matter of the people involved and how best one can motivate the people to highest performance."

Many times since he reported on the job, he has said he prefers to get things done first and to talk about them second.

What does Dr. Glennan think about private industry and the role it must play in our national space program? I haven't talked with him about this, but I have read a major address of his, titled, "Industry's next step in atomic energy", made late in 1952, just after he had completed two years as a member of the Atomic Energy Commission.

"Among the things I brought with me," he said of his going to the AEC -- in 1950, "was a strong belief in the essential rightness of the American system of free competitive enterprise, and a strong conviction that it could be made to work in the development of atomic energy just as effectively as it has worked in all the other industries which have helped to make the United States the great free nation it is today."

Later in his speech, he said, "I believe you will see why the government cannot be expected to carry the ball alone on this matter of industrial participation. The Commission's main job, as described in the atomic energy law and as dictated by the times, is to guarantee the common defense and security. It is a big job, and a time-consuming one, and if anyone thinks that the Commission can take time off from its defense work to look around for something to hand to industry on a solid plutonium platter, he is not being very realistic. Let there be no mistake about it: Industry will get only those things that it can prove it really wants, it can really handle, and it really should have in the public interest."

As I said, I haven't talked to him about his views about the part of private industry in the space programs, but if I were a wagering man, I'd bet a penny or two that if you substituted space for atomic energy in what I've just quoted, you'd be very close to knowing what Keith Glennan, NASA Administrator, thinks on the subject.

For my own part, I am convinced that what needs to be done to bring us to a position of leadership in space research and exploration will require the very best efforts of all of us.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE PRESS CONFERENCE

November 6, 1958

Auditorium
1520 H Street, N.W.
Washington, D. C.

P R O C E E D I N G S

MR. BONNEY: Very simply, ladies and gentlemen, what this is going to be is a press session on the mechanics of space flight. We are not going to talk about specific projects, but we are going to try to present some of the basic, fundamentals and we will have two of our scientists giving that presentation in about a half-hour period.

Then we will open the thing up for questions and answers. None of the speakers anticipate talking about any past, present or anticipated space programs. We expect no hard news out of this, but everything that will be said will be on the record and may be for attribution.

The speakers are Newell Sanders, Homer Newell and Jack Clark. I will give you the full names. It is Homer E. Newell, Jr. Homer is Assistant Director for Space Science. It is Newell D. Sanders. He is Assistant Director for Advanced Technology. The third gentleman is John F. Clark, who is Chief of our Ionosphere Program. John will not be making a formal presentation, as I understand it, but will be participating in the question and answer period.

One other thing: If the whole operation gets too technical or you get lost, throw in a question from the floor as we go along, but let's try to keep those brief. Let's try to keep most of the questions for the question and answer period that will follow the formal presentation. These gentlemen are all from NASA.

QUESTION: Will there be a transcript?

MR. BONNEY: We expect it will be a couple or three days before we have copies of it. This is so these gentlemen can clean up their remarks a little bit and pull some of the "oohs" and "aahs" out of it.

QUESTION: Do you have any more envelopes with the handouts?

MR. BONNEY: They have nothing to do with today's presentation. We will give you those at the end of the session.

Homer Newell will be the first speaker. Mr. Newell.

MR. NEWELL: Thanks, Walt.

Ever since 1945, as you are well aware, the United States has been using rockets for studying the earth's atmosphere. These rockets we call sounding rockets, and for the purposes of now and in the future, I would like to propose a definition of sounding rocket.

Let us say that by sounding rocket we mean a vehicle that goes out to one earth's radius, or up to that distance. Thus, when we talk about space probes, then, we will mean vehicles that go out beyond the distance of one earth's radius from the surface of the earth.

With the sounding rockets over the past 12 years we have been able to investigate the atmosphere of the earth and to study its pressure, temperature, density, which are important in the design of vehicles that go through the atmosphere, either launching vehicles for satellites or high altitude aircraft, and so on.

We have been able to measure the winds in the atmosphere and to study its composition, both the neutral molecules and atoms and the ions. We have been able to measure the magnetic field of the earth and to observe those variations in magnetic field that are associated with radio blackouts and, hence, are important to understand in connection with communications.

We have been able to measure the ionosphere, which is the region of our atmosphere that is electrified, and, of course, again is important for radio communications.

We have been able to study the aurora, the northern and southern lights, and other radiations from the upper atmosphere and make measurements of cosmic rays.

All of these things that I have mentioned are associated with the atmosphere itself. In addition to studying the earth's atmosphere, we have been able to peek out into the space about us to study the sun by means of its radiation and to, in fact, study the stars not only in the radiations that we see at the ground, but in terms of ultraviolet light and X-rays that come to us from the stars.

With advancing technology we can go beyond the studies that have been possible with sounding rockets. We are able to send up satellites that can go in orbits near the earth or in space probes that go out on long trajectories at great distances from the earth.

The details of the mechanics of creating these satellites and getting these space probes out into space is what Newell Sanders will talk to you about a little later.

The question that I would like to discuss is what are we interested in measuring and observing by means of the satellites and deep space probes?

To begin with, the scientist, in his usual logical fashion, would like to ask himself by means of his instrumentation the question of where does our atmosphere really end, and when it comes to an end, what does it wind up as? Does it, for example, wind up as simply the medium of interplanetary space, just a few particles per each cubic centimeter, or does it, as many people think, wind up as part of the sun's atmosphere?

You have all seen pictures of the sun's corona as it appears during a solar eclipse, this great halo around the sun. This actually is part of the atmosphere of the sun.

Now, the question is does that atmosphere really extend all the way out to the distance of the earth, and are we enveloped in a cloud of particles that belong to that solar atmosphere?

The second question that the physicist would like to ask is how far does our ionosphere extend? We have indications from rocket soundings and from ground-based measurements that there is a considerable amount of charged matter between us and the moon. We would like to learn the details of that.

Thirdly, we would like to know how the earth's magnetic field continues to fall off. Does it fall off as one would imagine in a more or less steady way, or is it modified by the material in space by the electrified particles in space, and so on?

Fourth, we would like to continue our study of the high-energy particle radiations like the cosmic rays and this is, as you know, continued in the satellites and space probes that have been launched to date.

The Van Allen radiation belt is a discovery in this area although these particles are not cosmic rays since they are not that energetic; nevertheless, they are of a similar nature. We would like to know whether this radiation belt continues all the way out to the moon or does it reach a maximum and then trail off?

Then, of course, if you look to the future and ask yourself the question of what future manned spacecraft we will run into, this radiation question is of extreme importance.

Going further, looking toward the future, we would like to ask several questions about the moon and planets. If we get our space probes to take our equipment to the vicinity of the moon, then we have a number of questions.

Does the moon really have an atmosphere? We know that it can't be much of an atmosphere, because we would see a halo around the moon if there were much of a one. If it has an atmosphere, say, of heavy gases, say Argon, Xenon and Crypton, is that ionosphere?

Does the moon have a magnetic field? What is the moon's gravitational field like? By studying the moon's gravitational field, one can get a measure of its precise shape.

As you all know, the moon is not a perfect sphere nor is it a simple sphere with a bulge around it the way the earth is. The moon is more like a lopsided football with three different axes to it.

We would also, in the more distant future, like to ask similar questions about, say, Venus and about Mars. What is the atmosphere of Venus really like? When we observe

Venus at the surface of the earth by means of ordinary astronomical techniques, we see great clouds of carbon dioxide, but we don't see any water vapor. Our first question is, is it true that Venus has no water? I do not believe this is true. I believe when we look into the atmosphere we see only a portion of the atmosphere where there is carbon dioxide, but if we could look further into it we would find water vapor.

The question is, is this true? What is the total atmosphere of Venus like? Does it have an ionosphere? Does Venus have a magnetic field and are there entrapped particles around Venus like those of the Van Allen belt around the earth?

Then turning out to Mars, does Mars have in its atmosphere any appreciable amount of water vapor? We suspect not. Does Mars have an ionosphere? When we get close to these objects, of course, we would like to take pictures of them to study them directly by photography, by television or any other means.

This is a very brief review of the things we would like to learn. They represent a step forward, a logical series of steps forward from things that we have been measuring in our own earth's atmosphere.

As we attempt to make these measurements and studies, we are sure that other questions will arise and other challenges, and we will want to pursue those.

Now, at this point I would like to turn the floor over to Newell Sanders, who will tell you something about the mechanics of getting these instrumentations out into the space that we would like to study.

QUESTION: You say by studying the gravitational field of the moon you might be able to find out what?

MR. NEWELL: We can find out more about the mass, size and shape of the moon, because the mass, the size and the shape of the moon determines the nature of its gravitational field, so conversely, by studying the nature of the gravitational field we can learn about its shape.

QUESTION: What is the size of that bulge that is to be determined now?

MR. NEWELL: On the moon, I can't give it to you offhand, but it is quite marked. It is more marked than the bulge of the earth.

MR. SANDERS: The first thing I would like to discuss with you is how we get out into space, what kind of path do these objects that we push out there follow?

For most of the flight, practically the entire lifetime of these vehicles, they are just flying through space, just drifting through space, as it were, for a period of perhaps five minutes near the beginning in which they get this violent acceleration from the rocket that pushes it up, but once this acceleration has died out and the rocket is dropped and the vehicle proceeds through space. It is flying on a trajectory in the same way that the moon and the other objects in our solar system are moving, following the same laws that the astronomers have worked out.

Now, let's take a look at a few of the kinds of paths that will be followed and I will start with the one that you are quite familiar with, the orbit around the earth, just as a starting point, and you are familiar with some of these concepts already, which is where we have essentially a circular orbit around the earth.

This is the earth. The vehicle is moving with the velocity such that it rotates around the earth. The centrifugal force which is generated just balances the gravitational force of the earth, and as a consequence, it will follow this path and not fall into the earth.

Starting from that point, we would like to reach out into space; we would like to go out to the moon, to Venus and to other parts of our solar system, and the question is how do we modify this system, this orbit, to get the kind of path that we want, having restored it?

Let's assume this vehicle has on it a rocket, and as it comes to this point we fired this rocket and gave it a velocity which is greater than the velocity that it would have just for this circular orbit. When we do that, due to the greater velocity, it will not curve quite as much. It will fly farther away from the earth and follow an elliptical path, something like this. But all of these paths will always come back and pass through this same point.

If we apply still a greater velocity, we will get something like this. Let's look at what these velocities are. For the circular orbit, this velocity has to be 18,000 miles per hour, roughly.

QUESTION: Are these statute miles?

MR. SANDERS: Yes, approximately. I know these numbers quite well in per-second, but I can't quite convert them in miles per hour.

If we continue to increase this velocity by use of increasing rocket charges, we will get a family of ellipses which extend farther and farther into space. In general, as these vehicles move around these orbits, as they move away from the earth, they will slow down and will be going at a slow velocity at these points and they start falling back to the earth and, again, are going at the velocity in excess of 18,000 miles per hour at this point.

If we keep on pushing that velocity up, until we get to 25,000 miles per hour, a strange thing happens. This ellipse never closes itself. These arms extend on out into infinite, and the vehicle will in a sense escape and keep on going and, in a sense, never come back.

There is a misconception here that I think it would be well to clear up. The vehicle has not escaped the gravitational field of the earth in the sense that the gravitational field of the earth has disappeared. The field of the earth extends to infinite, and it is permanent and it will always extend to infinite, so this vehicle will be in the gravitational field of the earth forever.

However, the point is, the gravitational field does decrease with distance. It is the inverse square of the distance. As the vehicle goes away, it is slowing down. When you lift something to higher altitudes, it loses velocity. It is not losing velocity at a fast enough rate. It cannot rob the total energy from the vehicle. This energy remains and continues and pushes the vehicle out into space, but it still feels the effect of gravity, but it will never return to the earth.

Now, then, let's suppose instead of going out far into space we think about going to some intermediate objective, such as the moon. We would like to extend these ellipses until the ellipse comes out far enough so that is reaches the moon orbit and to do that we need the velocity of 23,900 miles per hour. This brings up an interesting point. Actually, going to the moon, the step between going to the moon and escaping entirely is not a very big step.

As a matter of fact, if we miscalculate the size of our charge in our rocket system, or do something incorrect in our guidance, it is quite possible in shooting at the moon that whereas we would like to obtain a velocity such as this, we would escape entirely and go on out into space and never come back.

Actually, even if we do provide the correct velocity, we still have a problem. The figures I have drawn here(assuming that there are only two bodies in the universe, the earth and the vehicle) but the moon is out here somewhere, and it distorts the gravitational field to the moon when you distort this path. As this vehicle is traveling some elliptical path to strike the moon, actually instead of continuing to slow down and reach its lowest velocity here, it will start to speed up because it will begin to fall toward the moon and the moon will start tracking it.

We will assume we are not so accurate that we are going to hit the moon. I will not make such an optimistic guess as that, but if the vehicle comes real close to the moon as it goes by, it would speed up to a velocity of about 5,400 miles per hour; that is, it had 23,000 here, but it is slowing down and reaches a very low velocity here, but then it does speed back up to this number, and if it were to hit the moon, it would hit the moon at that velocity.

QUESTION: What is this velocity that it slows down to?

MR. SANDERS: I am sorry. I cannot tell you what it is. It is somewhat lower than that.

QUESTION: I had an astronomer figureout for me and he said it would be in the order of half a mile a second as it moved into the lunar gravitational field.

MR. SANDERS: Yes, and this corresponds to one and a half miles per second. If this vehicle comes close to the moon and goes on it will not stay in the vicinity of the moon because it would simply be deflected and then after it reached this maximum velocity and, going away from the moon, starts slowing down, it would never come back to the moon; it would go on over and continue around some path around the earth.

To make it stay in an orbit around the moon we have to have a retrorocket to slow it down and bring it down to a velocity necessary to make it stay in orbit around the moon. It depends on how close to the moon you are. It might be some velocity on the order of, in one case we calculated, 3900 miles per hour, but it depends on the orbit that might be chosen. These numbers in no way apply to anything that is imminent. These are just general calculations we have made.

QUESTION: You say that what you are attempting to do, then, is to slow this rocket down to a speed approximating 3900 miles an hour?

MR. SANDERS: In the particular case I have chosen. In principle, if you slow it down to a velocity less than this, it will follow through some elongated ellipse and if I wanted to put it down real close to the moon this is the number that I would have.

QUESTION: What do you mean by a "real close orbit"?

MR. SANDERS: This is a calculated figure in about one moon's radius; but don't relate this in any way to anything that is going to happen. These are just calculations we have made just to give you some idea of the magnitudes involved.

QUESTION: The moon radius is what?

MR. SANDERS: Isn't the diameter of the moon about 1000 or 2000 miles? In other words, the moon's radius is about 1000 miles.

Now, let's go back to the case where we have given it accidentally too much velocity and it not only goes by the moon and misses the moon, but also so much velocity that it will not stay in orbit around the earth. It goes on off and never comes back.

I said that, but that is not quite a correct statement. Again, we have neglected something, and that is this big old sun sitting over here which is exerting a tremendous influence on the orbit of these things.

What happens is this thing falls into an orbit around the sun. The velocity of the earth in orbit around the sun is around 66,000 miles per hour, and the velocity after the vehicle gets far away from here relative to the earth was of the order of a couple of thousand miles per hour, a very low number, so essentially it is traveling right around the sun at the speed of the earth or close to it.

Many, many years afterwards, presumably both the earth and this vehicle chasing the sun -- they might come together, but it will be years off -- so essentially we can say this vehicle is off if it gets to a greater velocity than this.

If we wish to go out in space to go close to Venus or go close to Mars, we are still dealing with a velocity of this order of magnitude, this escape velocity from the earth itself -- 25,000 miles per hour. But now we have to take into consideration the velocity of the earth and the velocity of the planets we are dealing with.

I will now draw the sun in a small block here. Here is the orbit of the planet Venus, orbit of the earth, orbit of Mars. Let's say the earth is moving in this direction, and at this point we wish to initiate a flight that goes to Venus.

If we shot it away from the earth at 25,000 miles per hour, when it got a little distance from the earth and it slowed down to orbital velocity it would follow it around so we have to slow it down. Actually we would do a firing in the opposite direction, but for the sake of simplicity we have to slow it down and put it into an ellipse like this.

If we left it with the velocity it would have after it escaped from the earth, when fired at that velocity it would follow around with the earth. By slowing it down, it would go into an ellipse and if we pick the correct velocity it will comd around and intersect the orbit of the planet Venus.

If we want to go to Mars, we must do the opposite; we must speed it up and make it go into an ellipse which comes around and comes close to the planet Mars. If we wanted this vehicle to stay in the vicinity of Venus when it got there, actually on this path it is going faster than Venus and it would go right by, so again, we would have to put on a retrorocket.

In the case of Mars, it is the other way around. We have to speed it up when it gets to the planet Mars. There is one other point I would like to discuss very briefly.

We know the laws by which these things move through space and we can predict it very accurately. If we had two boosters or rockets sitting on the ground, firing identical loads, giving the same velocity at the same point away from the earth, they would then –– we could calculate –– we would know they would follow absolutely parallel paths.

Now, suppose I was one of those objects and my lunch bucket were the other object. We would be flying through space and I would look out and see this lunch bucket right beside me. A little while later it would still be beside me. I would put my shoe out there and it would follow me around, too.

If I wanted to be gruesome about it, I hack off half my arm and it would go right along with me. It had been given the same velocity and same position I had been given. Now, that means even though my arm was attached to me here, there would be no force existing on that arm to move it relative to me; it would not be moved up or down or to the sides. In other words, I would not feel the weight of that arm at all nor would I feel the weight of any other part of my body. Therefore, I would feel that I was in a weightless situation.

But again, there is a misconception here. We are not free of gravity, because gravity is a thing that makes us travel in these elliptical paths. If there were no gravity, we would follow a straight path, so we are still subject to the laws of gravity.

The thing is, they are acting in the same way on all parts of me and I have the sense of weightlessness and that would be the situation of a man who was traveling in one of these unpowered orbits.

This concludes my discussion.

Q Doctor, when a rocket leaves the earth and you take advantage of the rotational speed of the earth, which is what?

A It is about a thousand miles per hour at the Equator.

Q Does that mean that that thousand miles an hour is added to the inherent speed of the rocket itself?

A If we take an Equatorial launch and launch it, we are taking advantage of it in the firings that have been done so far. So if we require a velocity of 18,000 miles per hour, actually the rocket system would only have to provide 17,000. However, let us suppose we wanted to put it into a Polar orbit, fire it so it can go over the Poles, we cannot add this velocity, so it is just in this special case, and we try to take advantage of this velocity, but in many missions we will not be able to do this. Some mission will call for something different, and we will not be able to take care of that.

Q When you fire from Cape Canaveral in a northeasterly direction, how much added speed are you getting?

A If you fire directly east at Cape Canaveral I think it is around 900 miles per hour.

Q You never do. You fire either southeast or northwest. I was asking if you fired into the northeast, like the Explorer Four.

A About 800 miles an hour, I am just told.

Q You have a figure of 23,900 miles per hour. Is that the desired velocity for this Trajectory you are talking about?

A Yes, that is a velocity which will have an ellipse that will become tangent to the moon.

Q At what altitude is that attained?

A That is an equivalent velocity that must be given at the earth's surface to this.

Q From the standpoint of actually firing a projectile in the direction of the moon, what burnout velocity would it attain?

A I don't know. Usually there is a burning period of about five minutes, and the load has to be adjusted and it depends on the accelerations that you give. If you have an acceleration of 1.3 times gravity this might go to a couple of hundred miles at which time it burns out. I cannot quote you right now on the velocity of this.

Q How close does this 23,900 have to be? How much variation can you have to limit yourself to a successful orbital moon?

A I cannot tell you exactly. I will point out one point. When you pick this minimum energy situation that I have described in which the ellipse it is traveling on is tangent to the orbit of the thing you are coming to it is fairly insensitive to the errors there. But you frequently like to use more than this minimum energy type of operation from other considerations. Sometimes you would like to give the thing a little extra push and have this ellipse do things like this and pick up points like this. That is particularly true in the case of going to Venus or Mars. We would like to shorten the time it takes to get there. It takes quite long on this minimum energy ellipse. As far as the accuracy that is required is concerned, it is quite stringent actually and the chances of getting to the moon are pretty low.

Q Can you give me an estimate. Suppose you picked out what you wanted to do, and you decide that you want to sort of hit a tangent-type thing when you reach the moon, what kind of accuracy must that be in miles per hour, roughly speaking? Is it in the neighborhood of twenty or fifty, or several hundred, or what? How close would it have to be?

A It is much closer than twenty.

Q Would you say it was within five miles per hour?

A You are pinning me pretty close here.

Q Just a rough estimate.

A Yes, that would be about right.

Q You had to be within five miles per hour to do what?

A Don't go away quoting me that five miles per is the number here.

Q In other words, when you pick the orbit that you are trying to hit, be it a tangent or one that goes out and comes back, there are probably a limitless number of those, and then decide on what your speed must be, roughly speaking how close do you have to hit it?

A I would like to make a comment here. I think in the way you posed your last question, you presented a problem correctly. If you are trying to hit a specific point on the moon or a specific orbit around the moon, when the requirements are extremely stringent, and an amount, as indicated, before doing better than a few miles per hour. Also, your aiming has to be good. But this is not the way you do something of this sort, certainly not on the first go-round. As you indicated, there are infinitely many orbits around the moon that one could shoot for, and this relaxes somewhat the requirements on you. As long as we get into an orbit about the moon, that is sufficiently close, we are in. So this relaxes the aiming for us, but as far as getting close enough to the moon is concerned, we are still within this few miles per hour requirement.

Q Could you discuss the question of problems to Mars and Venus in terms of launching times. We are more familiar with the three days per month Lunar problem. How does that work out with Venus and Mars?

A That is a much less frequent occurrence. Because of the energy requirements we do have to stick fairly close to this situation which I have illustrated here -- when the earth is in this position it is launched here, so it will meet

Venus when Venus is at this point. That occurs once, I think, about 225 days, as I recall. The period of the earth is 365. I think it winds up that this thing occurs about once every eighteen months that you get this combination of positions at the right time so that you can fire a minimum energy type of thing.

Q How about Mars on that same point?

A It is a much longer period of time there. Now, we want to fire it from the earth, and then when Mars is at 180 degrees, the vehicle will arrive at the same time. There are some other things that enter into this thing, too.

Q What is the period on Mars?

A I think that is 687 days.

Q That is Mars, period.

A That is what the question was.

Q What is the interval for a good shot?

A I don't have that in mind, but it would be longer than the 687.

Q It is around four to six years.

Q You don't have an estimated date when these two bodies will be in those positions, do you? They are going to be there regardless of whether we do anything or not.

A Yes, the astronomers know this quite accurately.

Q Can you suggest an approximate date?

A Those events will occur this year sometime as far comes around to the spot where at that moment the moon's orbit crosses and project your vehicle out into the plane of the moon. This is what I mean by flexibility.

Q Dr. Sanders, approximately how many millions of miles are represented in the elliptical paths that take 151 and 247 days?

A The closest approach there between Venus and Earth, I think the distance is around 24 million miles. That is the straight distance. I have to make a little calculation in my head to do this. The earth is 93 million miles from the sun, so we could say that probably you could represent that by a circle whose radius is, let us say, 93 minus a half -- let us make it about 80 million miles as the radius. Therefore, it is 80 million miles times pi, or 240 million miles.

Q Half of that to go from the Earth to Venus?

A I picked a radius there, so multiply the radius by pi, which is half already.

Q About 120 million or 240 million?

A 240 million, roughly, to Venus.

Q And about what for Mars?

A Yes, it is more for Mars. Mars comes within about 36 million miles to earth. It would be about 350 million miles. This is a rough calculation.

Q This is the diameter of the orbit?

A It is half-way around the complete ellipse.

Venus is inclined about 3 degrees. Mars is pretty close to the same plane.

Q Are plans afoot now to make launches or to try to make launches in the first half of 1959 and in 1960 for Venus and Mars respectively?

A I don't know what it is there.

Q To return to Canaveral, what is the optimum angle of launch? We read apropos the PIONEER that there was an error of 4 degrees or something in that order.

A Do you mean optimum angle to reach the moon? If that is what you are talking about, I don't know the answer to that.

Q The story was the vehicle encountered excessive gravitational pull which reduced its velocity by, I think, somewhere between 300 and 500 miles at the crucial stage.

A I think there were a combination of things that have not been sorted out. It was not just one item that caused that.

Q I am talking about a theoretical flight now. There must be an optimum angle that you could work out in celestial mechanics.

A Yes, and it is set by the inclination of the orbit.

Q Do you know whether we have hardware on the shelf that could be adapted in a year and a half to approach Venus and Mars?

A Yes, essentially the booster equipment is capable of it right now.

MR. BONNEY: Gentlemen, we have had a full hour of it. If you would be interested we can try to arrange one of these at a later time in the next two or three weeks and take another crack at trying to educate ourselves.

I want to thank these gentlemen, and then I might go completely off the record just to get into a couple of logistics for this evening.

(The Press Conference was concluded at 11:00 a.m.)

as Venus is concerned, latter part of 1960. As far as Mars is concerned -- correction, Mars is 1960. There are two dates. It takes 151 days for this to occur, so if Venus is in position here at the end of the year, this means somewhere along in the middle of the year it must be launched.

Q In the middle of what year?

A 1959.

Q That is for Mars?

A That is Venus.

Q What was that trip you wrote for Venus?

A 151 days. That is the minimum energy time.

Q This must come down to a very precise date that you have to send it up to reach the vicinity of Venus. Could you tell us what that date is?

A No, I can't. I don't know exactly.

Q Is this date in the last half of 1959 the date at which they are 180 degrees apart or the date on which you have to do your launching?

A The date that we would have to do our launching would be in the middle of the year. At that time Venus would be right here someplace, actually, and then in the time it takes the vehicle to move along this path, Venus will arrive here at the same time the vehicle does.

Q That would be down around seven o'clock?

A Yes, the earth would be in some position along here.

Q You would have to make your launching 151 days before Venus was down in that six o'clock position?

A That is precisely correct.

Q What about Mars?

A The same set of conditions hold true, and the flight time to Mars is around 250 days. I don't know that as exactly as I do this number.

Q It is 247.

Q So you would have to launch when and in what year for Mars?

A I don't know these dates. Somewhere in 1960 the earth will be in the correct position, such that 247 days later Mars will be in the correct position for it to strike.

Q It would have to be launched in 1960 to get there in 1961?

A That is correct.

Q What are these flight times based on in terms of velocity? It seems to me if you would accelerate you would be able to do it quicker.

A That is minimum energy. There you have an ellipse that just becomes tangent to the two orbits. As I stated you can generate an ellipse which goes across the other orbit and gives you a shorter flight time, and this is desirable certainly, but you are paying for it with energy and how far you are able to go is a technical question concerning the payload and what is available at the time.

Q To follow up this point, if you have a capability in terms of rocketry and guidance to go to the moon, how much greater a step is it to go on to Mars and Venus?

A From a propulsion standpoint, it is very great. The capability of the propulsion system to put it up is there, but it becomes a problem of guidance and communication.

When we talk about a very light weight vehicle carrying a radio transmitter and firing it fifteen million miles away, there is the question of getting the signal.

Q And there is ten to twenty minutes delay?

A That is right.

Q What is the time period during which on each of the days during your lunar probe launching you can still fire and hope to make it?

A I don't know. I think this would be a subject for discussions tonight. I don't know the answer to that.

Q It was eighteen minutes at Cape Canaveral.

Q Doesn't that go to this question of how you get there?

A May I put something in here. This depends upon the guidance system you have, the kind of course reckoning you can make and the kind of energy you have over and above the minimum energy required to do the paths. There are an infinite number of paths you could pick. If you restrict yourself to a fairly simple guidance system, fairly simple course corrections in flight, then this time interval is not very long. It will be on the order of ten to twenty minutes to get over in that period if you hope to accomplish a mission, defining a mission as merely getting into the vicinity of the moon.

If you go to the other extreme and had all the energy you could use and had very excellent guidance and so on, you could fire any time, because by definition you could fire and correct in flight. It depends upon the state of the art of propulsion and gadgets, and there is no precise answer except to say if you try to do it as simply as you can, you don't have very long. You have this ten to twenty minutes.

A If you had infinity power in your propulsion system, you could make it hit in a whole variety of positions here, but if you use the minimum energy, theoretically there is only one point. Then it is how much excess you have and so on that gives you freedom here.

A If you could go the speed of light, it would only take you one and a third seconds to get there. Let's take this as a limit. If you could possibly drive your vehicle that fast you could get there in about one second. If you got at minimum energy it would take 2.6 days.

A The fact that the launching site is not on the Equator gives rise to certain limitations on the time that this firing can occur, but this is not part of the discussion as we have made it.

Q Why is that?

A These vehicles travel in a plane. All of these orbits that we have here travel in a plane with the center of the earth. The mpon moves around the earth in the ecliptic, and as long as you fire in a position within the ecliptic you are not limited -- this is not quite a correct statement -- you are not limited in the time you can fire, but once you get outside of this ecliptic, you have to wait for these times when the plane of the moon -- this is a little complicated -- I would have to use a three-dimensional cardboard model to explain this.

Q What do you mean the moon travels in an ecliptic? What do you mean by this expression?

A The plane of the orbit of the moon is approximately in a plane of an ecliptic. It is inclined to some degree.

Q Let's try that again, please.

A If I may add a few words here, the solar system is essentially spread out in one plane, not exactly. The sun, the various planets, including the earth, all revolve essentially in a single plane. Let's suppose this desk is a plane here. When we look up on to the sky the inner section of that plane with the sky is the ecliptic, and one of the ways in which we can know where that ecliptic is, is by watching the apparent motion of the sun throughout the year. It simply seems to go around us. Actually we are going around the sun.

The moon's orbit also lies in a plane about the earth. However, that plane is inclined to the plane of the solar system, so you see the moon is going around an orbit, say the plane of this blotter, and intersects the ecliptic at only two points. When we fire an object out into space from the earth, we are essentially firing this object out into a plane coinciding with that of the ecliptic, so we have the problem of putting this object into an orbit in the ecliptic and making it intersect another orbit that is in a different plane which means that the intersection problem is even worse than if the two orbits were both in the plane of the solar system.

Q What is the angle of the moon's plane in relation to the ecliptic?

A That is six degrees.

Q Does it go up and down six degrees?

A Yes.

Q A total of twelve?

A It could be a total of twelve from the plane of our Equator.

Q Why can't you shoot your rocket in the same ecliptic as the moon?

A In the plane of the moon?

Q Yes.

A In the case of the moon, this can be done, but in the case of firing out to Venus, now this is more difficult to do, and again brings in the difficulty in aiming.

Q Have you made any changes in the PIONEER vehicle or the instrumentation?

A That is an out-of-order question. Ask it tonight.

Q How can you fire to get into the moon's plane? It seems to me you are determined from where you are firing from and you are in a plane and can't get out of it.

A This is what Newell Sanders meant when he said this increases the difficulty. In order to fire into the plane in which the moon's orbit lies, you have to fire at a time when your launching site is in that plane, or you have to direct your vehicle from your launching site into that plane and then have your last stage sort of dog-leg your trajectory into that plane.

Q In order to get into the moon's plane, you have to be six degrees north or south of the Equator, do you not?

A It is six degrees north or south of the ecliptic, and the ecliptic is 23 degrees 27 minutes at that angle to the Equator.

Q Dr. Newell, the main probelm is slipping the moon payload into the plane of the Lunar orbit around the earth. The inclination of the plane of the Lunar orbit never climbs as high as Cape Canaveral.

A That is the probelm.

Q In other words, the maximum is 28 degrees, and the maximum at Cape Canaveral is 33?

A That's right. If we were firing from the Equator our choices of times to fire would be much relaxed.

Q I suppose as a corollary to that is the time factor on the Soviet Union which has a much more stringent factor?

A Yes, I would say so.

Q Mr. Newell, would it be worthwhile to try to get an Equatorial launching site? Would the difference in what you would have to pay for it warrant it?

A I would say for many reasons it would be worthwhile to have the flexibility of firing from the Equator or from a northern site.

Q Has anyone suggested this to the Government?

A We have been thinking about that for quite a while, yes.

Q Dr. Newell, when you say you would have more flexibility, what would that be on the order of, once a week, twice a week, any time you want it, or what would it be compared to what you now have?

A I am thinking of just more than lunar and space probes when I say flexibility. If you fire from a launching site that is north of the Equator, let's say Cape Canaveral, or any other place like that, or in the Soviet Union, then your orbit will have to be inclined to the Equator at least equal to the lattitude of your launching site. You can't get an Equatorial launching unless you go through the procedure of sending up your launching vehicle, having a stage in it which will dog-leg it down to the Equator, and turn it parallel to the Equator and then have your final stages firing parallel to the Equator. Your launching operations then become very difficult and are difficult to carry out. However, if you are on the Equator you can fire in any direction and get an Equatorial direction or a Polar angle, or any other orbit. Being on the Equator you are simply related to rotational motion of the earth, and you can pick firing times so that when your launching spot can be at the intersection of the ecliptic with the Equator at the time you want to fire so that you can project into the plane of the solar system if you want.

Simply, the orbit of the moon crosses the Equator in two places, and you can wait until your launching site

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

FOR IMMEDIATE RELEASE
November 17, 1958

NOTE TO EDITORS:

The attached list, for your files, follows appointment by the President of William M. Holaday to be Chairman of the Civilian-Military Liaison Committee, as provided in the National Aeronautics and Space Act of 1958.

Mr. Holaday was appointed on recommendation of T. Keith Glennan, Administrator of NASA, and Donald Quarles, Deputy Secretary of Defense. Mr. Holaday will continue as Director of Guided Missiles, Department of Defense, pending organization of the new Directorate of Research and Engineering. He has occupied his present post since November 15, 1957. He joined the Defense Department May 2, 1957 as Special Assistant for Guided Missiles.

Assignments to the Civilian-Military Liaison Committee were made by the NASA Administrator and the Secretary of Defense.

Walter T. Bonney
Director of Public Information

November 17, 1958

CIVILIAN-MILITARY LIAISON COMMITTEE

William M. Holaday, Chairman

NASA MEMBERS:

Dr. Hugh L. Dryden, Deputy Administrator

Abe Silverstein, Director of Space Flight Development

Homer J. Stewart, Director of Program Planning

Ira H. Abbott, Assistant Director of Aerodynamics and Flight Mechanics Research

ALTERNATES:

DeMarquis Wyatt, Technical Assistant to the Director of Space Flight Development

Abraham Hyatt, Assistant Director for Propulsion Development

DEPARTMENT OF DEFENSE MEMBERS:

Agency	Representative	Alternate
OSD	Roy W. Johnson, Director, Advanced Research Projects Agency	John B. Macauley, Deputy Assistant Secretary of Defense (R&E)
ARMY	Maj. Gen. W. W. Dick, Director of Special Weapons, Office Chief of Research & Development, Dept. of Army	Colonel J. F. Smoller, Deputy Director of Special Weapons, Office, Chief of Research & Development Department of Army
NAVY	Vice Adm. R. B. Pirie, Deputy Chief of Naval Operations (Air)	Rear Adm. J. T. Hayward, Ass't. Chief of Naval Operations (Research & Development)
AIR FORCE	Maj. Gen. R. P. Swofford, Ass't. Deputy Chief of Staff, Development	Maj. Gen. M. C. Demler, Director of Research & Development, Ass't. Deputy Chief of Staff, Development

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

FOR RELEASE:
AM FRIDAY
NOVEMBER 21, 1958

RESEARCH ADVISORY COMMITTEES BEING FORMED BY NASA

Thirteen new Research Advisory Committees are being formed to provide technical counsel to the National Aeronautics and Space Administration. T. Keith Glennan, NASA Administrator, said he expects to have the committees functioning early next year.

At the same time Glennan announced formation of a new Special Committee on Life Sciences to advise the NASA on matters connected with human factors, medical and allied problems of NASA's manned space vehicle program.

In setting up the advisory committees, Glennan explained that communication and coordination with industry, universities and Government organizations are required in order to maintain aggressive, progressive research programs.

"Research Advisory Committees," he said, "will provide valuable assistance to the NASA. They will promote communication with other workers in the same or allied fields by reviewing research in progress, considering new problems, and making recommendations regarding the direction in which future research should go."

The committees will review research in progress and recommend problems that should be investigated by NASA or other agencies, and to assist in formulation and coordination of research by NASA and by other agencies. They will serve in an important way as the medium for interchange of information about technical investigations and developments in progress or proposed.

The committees will be concerned with the following fields: fluid mechanics; aircraft aerodynamics; missile and space craft aerodynamics; control, guidance and navigation; chemical energy processes; nuclear energy processes; mechanical power plant systems; electrical power plant systems; structural loads; structural design; structural dynamics; materials; and aircraft operating problems.

All members of the committees will be appointed in their professional capacities as individuals by the NASA Administrator and the committees will report to him. As far as feasible, committee membership will be kept small to facilitate discussion and decision.

Chairman of the Special Committee on Life Sciences is Dr. W. Randolph Lovelace II, Director of the Lovelace Foundation for Medical Education and Research, Albuquerque, New Mexico. Dr. Lovelace is an internationally known authority on aeronautical and space medicine.

Members are Capt. Norman L. Barr, (MC) Director, Astronautical Division, Navy Bureau of Medicine and Surgery, Washington, D. C.; LCdr. John H. Ebersole, (MC) Medical Officer, USS Seawolf, Fleet Post Office, New York, New York; Brig. Gen. Donald D. Flickinger, (MC), Surgeon and Assistant Deputy Commander for

Research, Headquarters, Air Research and Development Command, Washington, D. C.; Lt. Col. Robert H. Holmes, (MC) Chief of Bio Physics and Astronautics Branch, Army Medical Research and Development Command, Washington, D. C.; Dr. Wright H. Langham, Los Alamos Scientific Laboratory, University of California; Dr. Robert B. Livingston, Director of Basic Research in Mental Health and Neurological Diseases, National Institutes of Health, Bethesda, Maryland; and Dr. Orr Reynolds, Director of Science, Office of the Assistant Secretary of Defense for Research and Engineering, Washington, D. C. Boyd C. Myers II, NASA Headquarters, is secretary of the committee.

The new research committees will supersede the 28 technical committees and subcommittees of the National Advisory Committee for Aeronautics, which was absorbed by the NASA when it was established last October 1. The NACA committees and subcommittees are due to go out of existence next December 31.

- END -

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SCIENCE LECTURE
NO. 2

December 2, 1958

Auditorium
1520 H Street, N. W.
Washington, D. C.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D.C.

SPACE MECHANICS LECTURE BY DR. HOMER E. NEWELL, JR.

MR. ROSEN: Good afternoon, ladies and gentlemen. Welcome once again to NASA.

Today we are going to have our primer session. So you can be confused at the very beginning, we have given you these notes by Dr. Newell. Now Dr. Newell has very carefully prepared these and he is going to try and explain them to you word by word.

There are certain ground rules by which we must abide. One, everything that Dr. Newell says is on the record for attribution by name if you wish. This is a primer session in space or celestial mechanics. We are trying to limit the discussion to just that broad subject. Questions on space problems, past, present or forthcoming are what we would call out of order, out of bounds.

This is not a session on what is going to happen in the future or what the results were of things that happened in the past.

Most of you know Dr. Newell and at this point I will turn it right over to him.

DR. NEWELL: Thank you, Herb.

Did you get this set of notes here?

They are written on one side of the page with space for notes on the other side and I will attempt in the course of the next hour to try to make the notes clear to you. Do not hesitate to stop me and ask questions if they occur to you or if something has not been sufficiently explained.

We will begin by discussing the Law of Attraction, that is Newton's Law of Gravitation, and on the very first page you will note that we have written that this Law of Attraction can be expressed in the following form.

There is an error in the typing here. That "2" should be a superscript, so that we have the force of attraction between two bodies, one of mass, M, the other of mass, little m, that is proportional to the product of the masses, Mm, and inversely proportional to the square of the distance between them.

Now strictly speaking, this law is valid only for perfect spheres or point masses. We will assume in our discussion today that the sun and the planets and the satellites of the planets are perfect spheres so that we can use this law.

Now the first question I would like to ask you in connection with this law is that of how far this gravity extends. Suppose we have a gravitating mass like the sun, how far out does its gravity extend? Well, in figure 1, we have graphed curves that show the Law of Gravitation. Now, these curves are drawn on a special scale; if you will note, the scale runs in factors of ten, thus starting here with a 1 on the bottom, we go to 10, and then to 100, and then to 1,000, then to 10,000, and then to 100,000, and so on.

Similarly, on the vertical scale, we start at the top at 100, drop by a factor of ten, down to ten, then to 1, then to one-tenth, and one one-hundredth.

As you probably know, this sort of scale is called a logarithmic scale. It permits us to graph things that would not easily be graphed on a linear uniform scale, giving us the same accuracy down in the ten-thousandth and hundred-thousandth portion of the scale as we have up near 1.

In reading such a scale, you must remember that the divisions between the 1 and the 10, or between the 10 and the 100, are not uniform and this is the point in this extra sheet of paper here, which explains what a logarithmic scale looks like. This represents any one of the boxes in that graph (figure 1), and we could have here, instead of 1,2, 3, 4, up to 10, we could have had .1, .2, .3, .4, up to 1, or we could have had 10, 20, 30, 40, 50 and so on up to 100.

Or we could have had 10,000, 20,000, 30,000, and so on up to 100,000. And the same way here, so if in the box you are trying to find the point corresponding to four, you go over to where the 4 is here, and you see, it is not four-tenths of the way between 1 and 10, it is more than half way between 1 and 10. This you have to remember in using the graph here.

When you want to read in between the divisions, remember that one corresponds to the division, but 2, in the little scale that you see in the lower right-hand corner, will correspond to 3/10ths of the way between 1 and 10, so you go up 3/10ths of the way between 1 and 10 to get up to 2.

Likewise, on the bottom scale, you would have to go over 3/10ths to get over to 2.

Now, one of the great bits of usefulness about the logarithmic scale is that many curves are very simply represented on it. These straight lines represent the inverse square law curve, which on an ordinary uniform scale would be a bent curve.

And you will find as we go through the remaining curves here, other laws of this sort involving powers, rx, turn out to be straight lines on logarithmic plots.

Now, you don't need to go into the details of the points in the interior of the boxes here to get an overall picture of what is happening. Suppose we look at the curve labeled "Earth", the one in the middle here. At the bottom you will note what the labeling says, that the bottom scale represents the number of radii from the center of the body, so when you are using the earth curve, you remember that the distances involved here is given in terms of the length of the radius of the earth. So one earth's radius means one earth's radius from the center of the earth. So down here on the bottom, at 1, this is the line corresponding to one earth's radius from the center of the earth.

In order words, that corresponds to conditions on the surface of the earth, on the ground.

Now at the surface of the earth, the 1 up here, indicates the weight of one pound of mass. Well, one pound of mass at the surface of the earth weighs just one pound, in fact, that is how we define one pound of mass.

When we go out, say to the distance of the moon, which in this little table up here is 60 earth's radii from the earth, we must drop down on our curve to the point corresponding to 60 on the lower scale.

Now if we look up there we see that the weight of one pound of mass out at 60 earth radii, indicated right in here between 10-3 and 10-4, that is, one thousandth and one ten-thousand, we see that we have dropped down in weight by over a factor of one thousand.

At one earth's radius from the center of the earth, the pull of gravity on one pound of mass is one pound. Now if we go over a distance corresponding to 60 earth's radii, which is the distance out to the moon, and then go up to the earth curve, to a point right about here (indicating): Now that is, as you see, 1, 2, 3 and more orders of magnitude.

An order of magnitude is a factor of 10, so it (the pull) is more than three factors of ten down from one pound. In other words, the pull on the one pound mass has dropped off by more than one thousand.

On the other hand, there still is a pull there, it hasn't vanished, it hasn't disappeared, and in fact, if we go on out any distance whatever, although the pull drops off quite rapidly, as this curve shows, nevertheless, wherever we are, there still is a pull.

So the question, where does gravity end is answered by saying, it doesn't, but the force of gravitational pull on a given mass falls off quite rapidly; in fact, inversely as the square is the distance from the mass, and the rate at which it falls you can get from this curve.

Now, let's look at the upper curve here labeled the sun. Down at the bottom, again, the number of radii from the gravitating body, is what is used as the units, so when we use the sun curve, one means the number of sun's radii from the sun.

And if you look up at the table up here, a sun's radium is 432,000 miles, so when we are using the sun curve, the unit 1 then means 432,000 miles whereas when we were using the earth curve, the unit 1 meant 4,000 miles. And you will note in the table at the top here, some statistics, the earth is 215 sun's radii from the sun. You know, ninety-three million miles.

The sun, on the other hand, is 23,300 earth's radii from the earth.

The moon is 60 earth's radii from the earth. The earth is 240 moon radii from the moon, and then there are some astronomical facts. The sun's radius, 432,000 miles; the earth's radius, 4,000 miles; the moon's radius, 1,000 miles. These are approximately correct.

The sun's mass is 330,000 times the earth's mass, which is on the order of ten to the 26th (10^{26}) tons. Ten to the 26th power is 1 with 26 zeroes after it. You have that many tons in the earth, but we have 330,000 times as many in the sun. And the earth's mass is 80 times the moon's mass.

Well now, at one sun's radius from the center of the sun, in other words, at the surface of the sun, our one pound of mass would weigh 27 pounds instead of 1. In other words, the weight of any object taken from the earth to the surface of the sun would be increased by a factor of 27. You would weigh 27 times as much on the surface of the sun as you do on the earth.

QUESTION: Why?

DR. NEWELL: This is because the mass of the sun is so much greater than the mass of the earth, and you aren't far enough away from the center of the sun to counteract the increased effect of the mass. On the other hand, you are far enough from the center of the sun so that the factor is not 330,000 times.

Any other questions?

Now, coming down from the graph for the sun, at the bottom, we have a graph for the moon, which shows how the gravitational pull of the moon falls off. In this case, at the bottom, one means moon's radius, when we use this curve (indicating). So 1 in this case means 1,000 miles. The gravity on the moon's surface is 1/6th of what it is at the earth's surface, so on the moon's surface you would weigh 1/6th of what you weigh on the surface of the earth. It would be a lot easier to jump there, you could haul much heavier loads than you can haul on the earth; you can pitch a baseball much farther on the moon.

Now we can use these three curves to compare the gravitational attractions of these different bodies at a given point in space.

For example, suppose we want to compare how strongly the sun pulls the earth with how strongly the moon pulls the earth. We look up here and find that the earth is 215 sun radii from the sun, so, on the earth curve, we go over to where 215 would be That is in the 100 box here and over a little --

QUESTION: Following the sun curve?

DR. NEWELL: Following the sun curve, and mark a little circle about there, if you can see. Go over to 215.

QUESTION: 215 on the sun curve?

DR. NEWELL: On the sun curve; yes, sir.

DR. NEWELL: Now to get the attraction for the moon, we have to note in this table, that the earth is 240 moon radii from the moon, so we go over to a distance corresponding to 240 and go up to the moon curve and mark a circle about there (indicating) on the moon curve over to 240.

QUESTION: You really can't distinguish, can you, between those two figures in that one square by eye, could you?

DR. NEWELL: Not easily by eye. You will have to judge from this table here, 215 is essentially 2, so you would go over three-tenths of the way, and 240 is essentially halfway between, so you would go over about four-tenths of the way on the moon scale.

But now, notice the difference here between these circles. The vertical distance gives you the difference in attraction and you will find that the difference is about 200 times, so that the sun attracts a pound of mass on the surface of the earth 200 times as strongly as does the moon. And yet, the moon causes the bigger tides on the earth. Now why is this? Well, if we were to imagine the earth as fixed here, and the moon as fixed out here (indicating) and water on the surface of the earth, like this, the attraction of the moon on the water since the water can flow would cause all of it to pile up on the side toward the moon.

It wouldn't fall off the earth, because the earth's gravity would hold it to the earth, but nevertheless, we would have this pile of the water on the side toward the moon. However, as you well know, gravity of the moon causes tides to occur on both sides of the earth, and the water does not flow all to one side. Now why is that? Well, the answer is simply that the earth is not fixed in space, and it can move, and it can move under the attraction of the moon, so that we have water here (indicating) and water here (indicating). What happens is the following:

The moon's attraction on this water toward the moon is greater than the moon's attraction on the earth, the solid earth, and is greater than the moon's attraction on that water; away from the moon; because of the fact that this water is closer to the moon than the earth, and that water is farther from the moon than the earth (indicating). This causes this water here to fall toward the moon faster than the earth does. Well, that is just another way of saying the water will pile up, because it is falling towards the moon faster than the earth falls toward the moon and likewise the earth falls towards the moon faster than that water does, which means that water will lag behind, in other words, to someone on the earth, seem to pile up behind.

So this is how we get the piling up of the water on the earth which we call tides.

Well, now, the sun does the same thing, and we just pointed out that the sun's total attraction on any pound of mass the distance of the earth is 200 times that of the moon, nevertheless, the sun's tides, the sun's contribution to the tides is much smaller than that of the moon. Why? Well, the answer is this: That at the distance of the earth from the sun, the difference between the sun's attraction here (near side), the sun's attraction here (earth's center), and the sun's attraction here (far side), which is what causes the tides, is smaller in each case than the corresponding difference between the moon's attraction at the corresponding points. It is the differences between these attractions that pull these things apart.

The sun's attraction on the earth, at the distance of the earth, is varying much more slowly than the moon's attraction on the earth at the distance of the earth. The fact is that the attraction here minus the attraction here for the moon, is much bigger than the attraction here minus the attraction here (indicating) is for the sun.

Very simply, in numbers, you can put it down like this. For the sun's attraction, we have something like 201 here (indicating) and 200 here (indicating). The difference between the two is 1 unit in our attraction units, whereas in the case of the moon, we have something like 10 here (indicating) but 5 here (indicating). Don't use these figures as true figures, but as illustrative -- the difference is 5, in the moon case, let's say, whereas it is 1 in the sun case, and it is that difference that counts here.

QUESTION: Why should there be a difference, since the sun is pulling in the same direction on both sides, why doesn't it pull it all over? In other words, if you put a marble on the left hand side, it would be pulled over by the sun, just as well as by the moon?

DR. NEWELL: Yes, sir. Let's take the moon case here. You see, the attraction on the water here, is inversely proportional to this distance 5',squared, r. The attraction of the moon on the solid earth is inversely proportional to this distance 5^2, squared, r. Now, r is smaller than r^2, so when we divide by the square of r, we are dividing by something that is smaller than when we divide by the square of r^2.

QUESTION: Is the force strictly dependent on the distance? Wouldn't there be a difference because of density?

DR. NEWELL: Oh, yes, but what counts here is the force per each pound of mass. You can just think of each pound of mass individually and ask what will happen to it. Now each pound of water here is attracted, according to this law, in which the r that you use is on the average this r, r^1, and each pound of mass on the earth is attracted, according to this law, in which the r that you use is this one, r^1, which is bigger, and since you divide G by a bigger r squared here, you are going to come out with a smaller force per pound. We would replace this little m by one pound and the big M by the mass of the moon, you see.

QUESTION: Is there any effect on the atmosphere, does gravitation have any effect on the atmosphere?

DR. NEWELL: Yes, sir, it does. There are tides on the atmosphere, both moon tides and sun tides in the atmosphere, and these can be observed in the motion of the ionosphere.

QUESTION: Now without reference to space problems and so on, is it possible to measure these with satellite vehicles, these atmospheric tides?

DR. NEWELL: Yes, sir, it should be, and we hope in time to be able to detect those tides. Right now, in the early stages, from our satellites, all we can get is sort of an average, but eventually, when we perfect techniques, we should be able to detect the motions of the atmosphere itself.

QUESTION: So you might predict a high atmospheric tide and low atmospheric tide?

DR. NEWELL: Yes, sir, if it were worth all the effort of doing that.

QUESTION: Do you have to consider these three elements of the earth, the solid earth, the liquid sea, and the gaseous atmosphere as three different things in considering this?

DR. NEWELL: Yes, sir. The atmosphere, of course, would be above here, and it too, you see, would experience the pull of the moon, just as the ocean does, and just as the earth does. Now somebody might ask, what about the solid earth itself, isn't this subjected to this pulling apart due to the difference in attraction on this half to the attraction of this half, and the answer is yes. Yes, there is a seven-inch tide in the solid earth at Chicago, for example.

QUESTION: Is this in any way connected with earth quakes? Do you have this two a day, two highs and two lows on each tide?

DR. NEWELL: Yes, sir.

QUESTION: What effect is there, if any, on the earth? You don't have two earthquakes a day in Chicago?

DR. NEWELL: No, this is slow, you see, sort of a gentle pulling and relaxation, and the pulling moves around the earth, as the earth revolves, and as the earth rotates.

QUESTION: You used Chicago as an example. Is there a variation in geographically?

DR. NEWELL: Yes, sir, variation in the tide, depending on where you make your measurement.

QUESTION: Now, that seven-inch tide at Chicago, it would vary from what to what, geographically?

DR. NEWELL: Well, it is everywhere less than a foot, I believe.

QUESTION: What do you use to measure an earth tide? You use the earth to measure sea tide. What do you use to measure earth tide?

DR. NEWELL: That is part of one of the big problems that we hope to solve with satellites. One of the biggest problems in geodesy is what is the shape of the earth, the geoid, and what can we use as a basic reference? At the present time, one uses an ellipsoid of revolution with certain curvatures that are determined by gravity measurements made on the surface of the earth. Now these gravity measurements made on the surface of the earth are the difficult way of getting the shape of the earth. What you do is, if the earth obliqueness is exaggerated this way,and you want to measure the curvature at this point, you want the perpendicular to the surface of the earth. Now, what you can measure is the direction of gravity and the direction of gravity will be different from the direction perpendicular to the surface of the earth because of the fact that the earth is squashed out from a perfect sphere, so you make measurements all over the surface of the earth, getting this direction of gravity and noting the difference in angle between this direction and the direction perpendicular to the surface of the earth. After you have this at thousands of points around the earth, then you might be able to put together a pretty good picture of what this ellipsoid is.

QUESTION: May I ask, is this a factual thing, when you try to determine the perpendicular at this point of the surface, what do you use?

DR. NEWELL: For the direction of gravity, you use either a bubble, a level, or something equivalent to it. For the perpendicular, you use the stars, and assume that the earth is a sphere. Now, the assumption is incorrect, and that is what gives you the difference between the two, and having measured the difference, then you know how incorrect it is, and you get back to the curvature here.

QUESTION: You mean if the earth was a sphere, there would be no difference between those two lines?

DR. NEWELL: That is right, and in a ring about the earth at the equator there is no difference. Also, at the poles, there is no difference. But in between, there is this difference.

QUESTION: Doesn't the bubble, to finish the question, doesn't the bubble in the gravity indicator work on the basis of gravity, and if so, how can it show the true perpendicular?

DR. NEWELL: The point is it doesn't show the true perpendicular. It is the gravity one that is off. It is the star one that would be on, if the thing were a perfect sphere. It is the fact that there is a difference which leads you to estimate what is the best shape of the earth.

QUESTION: Would tides at the pole be greater?

DR. NEWELL: Greatest tides would occur at the equator. However, this term tides is confused by the fact that the height of the tides is also affected by the channels into which the waters flow. For example, at the Bay of Fundy, where there is a narrow channeling, you get these terrific tides.

QUESTION: You mean the earth tide rather than the ocean tides?

DR. NEWELL: I was talking about ocean tides.

QUESTION: Not to belabor this earth type thing too much, but is it of sufficient significance that an architect in designing a very large building like Empire State or Pentagon would have to take it into consideration or can it safely be ignored?

DR. NEWELL: I don't know the answer. I am not an engineer; I know that wind motions are bigger than this and the engineers have to take into account those, of course.

I wonder if we shouldn't go on to the next topic then. The next subject is that of orbits, and using the law of gravitation and a lot of mathematics, calculus, which I am not going to use here, one can show that the orbits of a body revolving about another gravitating body will be conic sections. Now a conic section is just what it says, section of a cone. If we cut a cone like this (indicating) perpendicular to the axis of the of the cone, we will get a circle. That is one conic section. If we slant our cut just a little, that circle will go out of shape a little, and we will get an ellipse, and so on, until we have slanted this so that the cut is parallel to this edge of the cone. In that case, we no longer get any ellipse, the other end of the ellipse has, so to speak, gone off to infinity, and we have a parabola. Now if we slanted some more, then we get a cut here, and if this cone were extended up in the other direction too, so we had both surfaces of this cone, we would get a cut up there too. And this (indicating) plus that, forms what is called an hyperbola.

The drawing in figure 2, shows you what the orbits look like. You have your circle, your ellipse, your parabola, and your hyperbola.

QUESTION: You have an object going into two different orbits at the same time?

DR. NEWELL: Of course, in any finite time, it stays on only one branch. In fact, as we will see a little later, if we give an object just the right amount of energy, it will go off to infinity, along a parabolic path. If we give it a little more than the energy required to send it off to infinity along the parabolic path, then it will move on a hyperbolic path. In either case, it will take infinitely long to get off to infinity. But in both cases, it will have been given enough energy to escape to infinity, given infinite time.

QUESTION: Dr. Newell, I don't see the difference between the parabola and hyperbola?

DR. NEWELL: The parabola is the case of the cut made parallel to the cone edge, so that we get one slice that doesn't intersect the other side of the cone here, but it doesn't hit the upper portion of this cone, either. But if we slant our knife, now, so that we cut like that (indicating), this is going to cut up here too, so we get another branch of it.

So the parabola has only this one piece, the hyperbola has two pieces. In fact, you can think of the curves as going this way. You have a circle. You start pulling this end of the circle away (indicating) that elongates it, but leave this end fixed. Now when you have pulled this away to infinity, you have a parabola.

If you could by magic come back from infinity in the other direction, back would come the other piece of the hyperbola that you now get.

QUESTION: If you cut the thing straight down from the top, does that have any meaning at all in this picture?

DR. NEWELL: To the mathematician it does. If you cut it straight down from the top you get what is called a degenerate hyperbola, because it is the case of the hyperbola when you move your cutting plane over to go to the center here, and the hyperbola then just becomes two straight lines.

Now, in the next page, in figure 3, we have some of the elements of an ellipse. When you are talking about satellite orbits, you are talking about elliptical orbits, and you hear such terms as semi-major axis, semi-minor axis, the foci, center, eccentricity and so forth. Now what are these?

Well, first of all, the ellipse. Even though it is a section of a cone, it can also be thought of as a circle that was uniformly squashed in one direction. If were to take a piece of rubber and on it draw a circle and then stretch that rubber in one direction, the figure you would get would be an ellipse.

Now, you know that the area of a circle is pi times the square of the radius. When we have the circle of radius r we have pi times the square of the radius. Now when we have an ellipse, we really have two radii, an "a" and a "b", the maximum radius and minimum radius. This maximum radius is called the semi-major axis. The major axis is the whole thing here, and the semi-major axis is half.

The mimimum radius is called the semi-minor axis. And the area of your ellipse now becomes pi times ab. It is very simple. You just replace one of the radii by the minimum radius.

The foci are genuinely what we think of foci. You have an ellipse which is shown here -- let me explain that. You know what we mean when we say focus something on a certain point. Well, if you have here, at one focus, a light source, the light rays going out from this focus will always be reflected to the other focus, if you think of this ellipse as a mirror. Hence the reason for calling these foci. They are places to which radiation from one of them will be focused.

QUESTION: Which is across the middle, the inside?

DR. NEWELL: Yes, sir. If, for example, you think of this as a cross-section of an elliptical room, and you stand here, and you speak, the sound waves going out to hit the walls of the room will be reflected to here (indicating), and you can arrange to have someone at one focus and yourself at the other and speak low enough so that a third person elsewhere cannot hear you, but the first person can hear you clearly, and I am sure all of you have experienced this. The Capitol dome is a good example.

QUESTION: In the case of celestial mechanics, it turns out if one of the gravitating masses is, say, M, and the other is m, m revolving in this orbit, M will be at one of the foci. It always happens that the one gravitating mass revolving about the other revolves in an orbit for which the attracting mass, the big mass is at the focus.

Now, one way of measuring the squashing of this circle to form an ellipse, would be to take the ratio of the minor axis to the major axis. However, mathematicians in their perversity, decided they wouldn't do this. Instead, they said, we will take the distance from the center to one of the foci,and we will call that c, and we will divide that c by the semi-major axis, and that we will call the eccentricity. The distance from the center to a focus over the distance from the center to the vertex here we call eccentricity.

Well, these things we will use later when we talk about the orbits of satellites, and elongated orbits of satellites that go out to the distance of the moon.

The next subject here is the question of periods of revolution about a body.

Now you have heard of Kepler's three laws of celestial mechanics. One of them, the Third Law, is that the period of revolution of a body about the sun is proportional to the three halves power of the semi-major axis of the orbit.

QUESTION: Will you repeat that, please?

DR. NEWELL: The period of revolution of the body in the solar system, a planet about the sun, is proportional to the three halves power of the semi-major axis.

Well, three halves power, that can be written another way, it is equal to the square root of the cube.

Now, in the graph of Figure 4 we have this power law drawn, and you will note that once again, it is a straight line, bringing out the advantage of using logarithmic scales. The period on the left here, as you look at it, is given in years. The distance on the bottom scale is given in units of the distance from the earth to the sun, 93,000,000 miles.

QUESTION: Is this a mean distance?

DR. NEWELL: This is the mean distance, 93,000,000 miles. We are ignoring the eccentricity of the earth's orbit. You note than at one astronomical unit, which is the distance of the earth, the period of revolution is one year. Well, sure, that is what a year is. If we go in to the distance of Venus, the period becomes .62 years. And if we go into the distance of Mercury, it is..24 years, and so on, out to the distance of Pluto. Now suppose you want to get the period of any body that we might put out such as an artificial planet, which is something we might do some day. We have talked about artificial satellites, and we have talked about lunar probes, and Venus probes, and things of that sort; you might also want to put out an artificial planet that keeps going around and around the sun.

Well, the period of such an artificial planet could be obtained from this graph by simply looking over to the distance from the sun, at which you wanted it to revolve, and looking up here and getting the period in years.

Now, as an intriguing memory device to remember the distances of the planets from the sun, let me present to you Bode's law. You write down these numbers: 0.3, and then twice 0.3, that is 0.6, and then twice 0.6, that is 1.2, and then twice 1.2, which is 2.4, and so on.

It is an easy series to remember, and then you add to each of these 0.4. You come out with 0.4 as the distance in astronomical units of Mercury. You come out with 0.7, as the distance in astronomical units of Venus from the sun. Here you come out with one astronomical unit as the distance from the sun to the earth. Here you come out with 1.6 as the distance in astronomical units from the sun to Mars; here, you come out with 2.8 as the distance in astronomical units to the asteroids.

The next one is Jupiter, and the next one is Saturn, and then Uranus. Neptune and Pluto don't work. So, you will have to just remember those two.

QUESTION: No scientific basis for this, is there?

DR. NEWELL: When I took celestial mechanics in school, nobody knew the explanation of this. Now, Fred Hoyle and a few others have come up with a theory on the origin of the earth which assumes that the earth from the various planets were formed by the accumulation of cold masses of particles into the big globs that were the planets, and this theory, interestingly enough, shows that these big globs will form at just these distances from the parent sun.

QUESTION: Why doesn't it apply to Neptune and Pluto?
DR. NEWELL: That is a good question.
QUESTION: Is this an indication there may be undiscovered planets in that area out beyond?

DR. NEWELL: If there were material out there, far enough from the sun to form them, there might be planets out there, yes, sir. What this indicates, though, more interestingly than that, is that according to this theory it is very natural for planets to form around stars, and therefore, that it is very likely that most other stars have a series of planets like this. Furthermore, it turns out that it is very natural for one of them to be at just the right distance for life to form, which leads to some interesting speculation.

QUESTION: Is this any kind of explanation for Saturn's rings?

DR. NEWELL: It is the same sort of thing. You know, Saturn's rings are divided into three bands, and the division in the three bands follows the same sort of law as this; yes, sir.

Well then, the last subject for today is that of energy. Now, this of course is basic to the engineering problem of getting --

QUESTION: Just a moment, on this other: Does this theory also account for the difference in size?

DR. NEWELL: No, it doesn't; not that I know of. The difference in size would be due to the amount of matter that happened to be at that distance.

QUESTION: Can you say why it is natural for them to form at those points? You say it is natural, but why?

DR. NEWELL: Well, the theory is quite involved, and I have never been through the detailed analysis. It simply comes out that if you set up a mass of material surrounding a parent sun with this mass of material revolving around, they begin to condense into globs and out of the theory drops the fact that they will condense at these various points.

Why? Well, you can't really answer that question why. When you construct a theory, you simply construct a mathematical structure that does or doesn't explain what happens. If it does explain what happens, you say the theory is right. If it doesn't, you go looking for another theory. Well, in this case, it happens to explain something that hadn't been explained for centuries, so we think the theory may be right.

QUESTION: Has this been physically demonstrated in a vacuum?

DR. NEWELL: No, not that I know of.

Well, I would like to run very quickly through the last subject before we conclude, and that is the matter of energy. As you know, the job of creating an artificial satellite or a lunar probe reduces to the engineering job of giving enough energy to an object that you are throwing out into space. Now the first thing to consider with regard to a gravitating mass is the energy required to get it to a certain position relative to that mass, a certain distance from its center, let's say.

Suppose we call that distance r. The energy of that mass, just by virtue of its position in the gravitational field of M, is called its potential energy. And physically, it is a very easy thing to visualize. The potential energy of this little mass here (indicating), at this distance from the center of M, is just the energy that it would pick up in falling from infinity to that point.

It turns out to be equal to minus a constant K over r, which goes inversely as the distance from M. Interestingly enough, the potential energy is equal to the kinetic energy it would have picked up falling from infinity to that point. This is very interesting because what it means is that if you have an object out here in space, and you give it kinetic energy, that is energy of motion, if you project it fast enough, so that its kinetic energy is equal to its potential energy, then it will escape in a parabolic path.

This is what it means. You have a body here, with a potential energy, E, and you give this kinetic energy equal to that potential energy E, it will escape on a parabolic path. If you give it energy greater than E, it will escape but on a hyperbolic path. If you give it energy less than that potential energy E, then it will follow an elliptic orbit and be a satellite body.

QUESTION: Dr. Newell, without regard to any shots, past, present or future, on the first moon shot, somebody got burned by the careless use of the words "escape velocity"?

DR. NEWELL: Yes, sir.

QUESTION: Would you define "escape velocity" for us with reference to this figure 36,677 feet per second?

DR. NEWELL: If you will look at the last figure, we have potential energy here, that is energy of position. We have kinetic energy, that is equal, for every pound of mass, to the square of the velocity divided by 2. And we just pointed out that the kinetic energy you have to get in a body to make it escape is equal to its potential energy at that point, so we can talk about escape energy or potential energy in terms of speed, if we want. We don't have to talk about the square of the speed, so, when we talk about escape speed, we mean the speed at which a body must move in order to go out to infinity along a parabolic path.

QUESTION: Does this mean entering a new gravitational field, leaving one and entering another?

DR. NEWELL: Leaving one and going to infinity relative to that one. If you will look at this graph (figure 5) again, at the bottom, we use distance from the particular body in terms of radii. On the one labeled "Earth", out here, you will note that it starts at one earth's radius, at the point corresponding to 6.94 miles per second or 36,500 feet per second.

Well, it is almost seven miles a second, that is what we call escape speed from the earth. If we project a body from the surface of the earth at that speed, it would go off to an infinite distance from the earth. But, look at the curve up here corresponding to the sun.

Again, now radii in this case means sun's radii for this curve. See the position of the earth, it is well above the position of the 6.94, which is the escape speed from the earth. In fact, it corresponds to 26.16 miles per second, so that even though you may have projected a body from the earth, so that it escapes from us, it has still not gotten away from the sun by a long shot.

QUESTION: So when you speak of going out to infinity, you mean this does not mean escape from the solar system?

DR. NEWELL: No. All we mean is that as far as the earth is concerned, we have lost control of it, but the sun still has it.

QUESTION: You need an extra 100,000 feet per second to get away from the sun?

DR. NEWELL: Roughly, yes.

QUESTION: Has anybody ever computed what escape velocity is from the entire galaxy?

DR. NEWELL: Yes, sir, it has been computed. I don't remember it, but it has been computed. The escape velocity at the surface of the sun is up here at the 1 position on this graph to the sun, and you see, that is 2 million feet per second, or 383 miles per second.

QUESTION: How does an object escape from the primary influence of the earth and get into the primary influence of the moon, that is, assuming that you have less than escape velocity in the first place?

DR. NEWELL: Well here, you have to use that first graph that we drew, showing the variation of gravity, and you simply project your body out from the earth, get it close enough to the moon, so that the moon's gravity, far exceeds that of the earth's, at that point.

QUESTION: And at the same time having it going slow enough so it isn't above moon escape velocity.

DR. NEWELL: That is correct. If you have a body moving out from the earth on an escape path, when it gets to the distance of the moon, if it is not close enough to the moon, it may well be going too fast for the moon to capture it, in which case then, you are going to have to do something to slow this down, so it then will stay with the moon.

QUESTION: That was the retro-rocket business?

DR. NEWELL: Yes, sir.

QUESTION: Dr. Newell, would it be possible to fire a space probe at less than escape velocity but have the moon somehow assist it in escaping the earth's solar system?

DR. NEWELL: Yes, sir, it could be done, but this would require, oh, a very accurate cut-off of your rocket, at the right point, so that when you have gotten out to just the right distance here, relative to the moon, the moon could catch it and pick it up.

QUESTION: Well, let us say you fire the rocket toward the sun instead of away from it, since the solar influence on the moon, is 200 times that of earth, presumably the sun would exert a far greater influence?

DR. NEWELL: Except, that you must remember this one remark I made about the earth and the moon, not being fixed so when you are talking about your object being out here (indicating) and being greatly influenced by the sun, more greatly than the earth, you must remember that the earth and the moon and this body are all being attracted by the sun, and the whole collection is going around the sun in the corresponding orbit.

QUESTION: Dr. Newell --

DR. NEWELL: Again, it is this question of the differences in attractions, that is what you must use.

QUESTION: Dr. Newell, does that mean then that an object shot hard enough, with enough speed from the earth's gravitational field, not stopped by the moon, would it rotate around the sun and would not be sucked into the sun?

DR. NEWELL: It will or won't, depending on the direction in which you fire it. If you fire it in such a direction that it goes in an elliptic orbit, this is fine. But if you happen to fire it in such a way that it is headed toward the center of the sun, and you fire it fast enough it will go into the sun.

QUESTION: When you fire an object in the direction of the moon, and at the time of a new moon, then you are running into exactly that problem, aren't you? You are firing it at the sun in effect?

DR. NEWELL: Well, not really, because don't forget there is this orbital velocity of the earth that your object already has.

QUESTION: Doesn't that mean --

DR. NEWELL: You have to fire it in such a way you not only let it escape from the earth, but you cancel an appreciable part of this orbital velocity.

QUESTION: Doesn't that mean that the center of mass of the earth moon system is going sideways about 18 miles a second, if you shoot it out at almost escape velocity, it loses most of that velocity and all it does is establish an orbit around the sun much closer to the sun perhaps, but still there?

DR. NEWELL: Yes, sir, that is why I had to say, if you shoot it fast enough. You have to shoot it fast enough and in the right direction to cancel an appreciable portion of that 18 miles a second.

QUESTION: But, it would not stay in orbit going slower than the earth unless it was farther out than the earth, would it?

DR. NEWELL: No, but you see, what happens is that if you fire it, say, in the opposite direction, so as to cancel this, then it immediately starts to fall into an orbit that goes closer to the sun, and picks up speed. So when it is closer to the sun than the earth, it is moving faster than the earth.

QUESTION: That would be a kind of glorified comet?

DR. NEWELL: Except, comets in general go in ellipses which are approximately parabolas.

QUESTION: Dr. Newell, with reference to figure 5, what is the velocity you would have to achieve in order to launch a vehicle to escape the earth's gravitational predominance and get completely out of the solar system? Which figure there applies? The 383 miles per second?

DR. NEWELL: No, because we are already at the distance of the earth.

QUESTION: 138,000 feet?

DR. NEWELL: 138,000 feet per second is the one.

QUESTION: Is this approximately the speed with which meteors come in and hit the earth?

DR. NEWELL: The meteors come in at anywhere between 7 and 40 miles per second. The seven miles per second is the escape speed from the earth and 40 miles per second is six times that.

QUESTION: Why six times?

DR. NEWELL: Well, that is a good question, they just do.

MR. ROSEN: Now gentlemen, I think the front end of this conversation may have been slightly fuzzy. Please do not hesitate to ask questions on that portion of it. I would like to throw this open for Q and A for as long as either Dr. Newell or yourself can stand it.

QUESTION: Dr. Newell, did you give us the escape velocity from the solar system?

DR. NEWELL: Yes, sir, the escape velocity from the solar system, if you start from the surface of the sun, is 383 miles per second. If you start from the distance of the earth, this is Figure 5, it is 138,000 feet per second. If you start from any particular distance from the sun, it is given by that upper curve labeled "Sun" and I have marked on that curve, the distances of Mercury, Venus, Earth, Mars, and so on, so you can read off from that, using a logarithmic scale, the escape speed at any distance from the sun.

QUESTION: The escape speed from the solar system at the orbit of Uranus would be about the same as the earth escape velocity here?

DR. NEWELL: Yes, sir, at the surface of the earth.

QUESTION: But that might not be enough to get you off Uranus necessarily?

DR. NEWELL: That is correct. If you are at the distance of Uranus and on Uranus, you would still have to, in fact, project it a lot faster than you would at the surface of the earth to get it off Uranus first, and then have to add your seven miles per second to get you out of the solar system.

QUESTION: Oh, beyond escape, you still need 7 miles more?

DR. NEWELL: You see, in effect, getting your object to escape from the earth, let's say, simply gets you to escape out to the point where you are moving around at your 18 miles per second, roughly. This isn't exactly at the distance of the earth, and by the time you get to moving at or close to 18 miles per second, you are already a goodly distance away, but roughly, you can say, you have to add the escape speed from your parent body, plus the escape speed at that distance from the sun.

QUESTION: Well, then, to escape the solar system, you would actually need 138,000 feet per second plus 36,500, is that right?

DR. NEWELL: Roughly. First approximation.

QUESTION: You need 36,500 of this which would be wasted in getting off the earth, and then you would need 138,000 more to get away from the sun?

DR. NEWELL: Yes, sir.

QUESTION: Is that it?

DR. NEWELL: Yes, sir.

QUESTION: Dr. Newell, would you go over that theory once more about the formation of the planets to tie in with that tidal thing?

DR. NEWELL: Yes, sir. This theory, as I recall, was first proposed by Weissaker. It is always an interesting name. This is the sun, suppose that we have clouds of --

QUESTION: No, this was to explain those distances, not the tidal.

QUESTION: I think he wants Bode's law?

DR. NEWELL: That is what I am talking about. Supposing we have clouds of gas, aggregates of particles, and things like that, which have formed subsequent to the formation of the sun. It is easy to imagine how this could occur. The sun originally would have condensed out of big gaseous clouds, and in this condensation, not all of the material would have gone into the sun. Some of it would have remained out in the space around the sun, would have cooled, would have formed into stones, and dust particles and so on. Now the theory shows that at certain particular distances, these clouds would begin to accumulate into globs. These globs would grow. As they grow, the terrific pressure that is built up, would tend to heat the globs up, and in addition, the radioactivity in the material would also add to the heat, so eventually they would become molten. The distances at which these globs grow, interestingly enough, come out to be the distances indicated by Bode's law. And since this applies to just a gravitating mass, with material around it, then there is no reason to suppose that all the suns in the galaxy don't behave according to this law, so that a large number of them, maybe as many as half of them, ought to have this system of planets.

And furthermore, it turns out that at the right distance for life, proper temperature, and so forth, in most of these cases, you would get one of these globs. So this suggests that maybe there are millions and millions of suns with planetary systems, with one planet at just the right distance for life.

QUESTION: But you are assuming life as we know it here?

DR. NEWELL: Yes, sir.

QUESTION: There might be other forms of life that may live at different temperatures?

DR. NEWELL: That only raises the probability of finding life elsewhere.

QUESTION: But Bode's law tells you that there will be one planet about like earth, 93 million miles from the center of the sun.

DR. NEWELL: Yes, sir.

QUESTION: You have a star the size of Antares that goes out to the orbit of Mars, and your nice comfortable little earth is a couple of million miles down inside of it. How does that figure?

DR. NEWELL: No, there would be a planet further out, which relative to that large star, would be at just the right distance as far as temperature is concerned.

QUESTION: How does Bode's law work out if you use the radius of the sun as a unit instead of astronomical unit as unit, does it still work out mathematically all right?

DR. NEWELL: I don't know if it is easy to convert. I think the law would turn out to be much more complicated. You certainly could convert it, but it would not be the convenient memory device that it is in its present form.

QUESTION: Dr. Newell, does this law hold that at these particular distances, a planet of a certain size will form or does it hold that a certain number of planets will form?

DR. NEWELL: It holds that a certain number of planets at certain distances will form.

QUESTION: At certain distances?

DR. NEWELL: The size will depend on how much mass and material there is around the sun.

QUESTION: How does this square with the distances of the satellites of Saturn and Jupiter, or would it apply there?

DR. NEWELL: The principle is the same. I can't know how closely they compare.

QUESTION: Well, does this law imply that there might be yet undiscovered planets that the law would infer exist?

DR. NEWELL: It would, except that as I pointed out, Neptune and Pluto don't seem to behave properly.

QUESTION: With reference to them, Dr. Newell, to Neptune, you carry Bode's law through Uranus. The next one would come out at 38.8 astronomical units, and is Neptune farther or closer?

DR. NEWELL: 30.

QUESTION: It is closer?

DR. NEWELL: Closer, and Pluto is closer too.

QUESTION: Where is Pluto?

DR. NEWELL: The distance to Pluto will be 39.5 astronomical units.

QUESTION: Dr. Newell, is the point of greatest gravitational pull always toward the center of any mass?

DR. NEWELL: No. It happens that if you have a perfect sphere, then that sphere behaves as though all its mass were concentrated at the center. But if you don't have a perfect sphere, then that no longer holds necessarily. And in fact, that is the reason why the bulge on the earth gives us those interesting effects on the artificial satellite orbits. You could, for example, have a mass that is shaped like a dumbbell, or have a dumbbell, in which case, you see, the center of attraction will be here (indicating), not close to the center of the rod.

QUESTION: How is it then that these globules that form the planets at these intervals become spherical in the first place? I should think they would be eternally plastic?

DR. NEWELL: Well, in that case, you see, if you have a plastic material, you have exterior to the material forces pulling on the surfaces, and these forces pulling on the surface here, will tend to make the surface as small as possible, to make the matter crouch down into the smallest region into which it can get. You see, if it were in a bigger region, then the forces operating on this will make it move, if it can.

So, it moves into the smallest region possible and that is the most pulling together that can occur. Well, geometrically, you can show that a sphere is the geometrical body which has the largest volume for a given surface.

QUESTION: Isn't it still plastic?

DR. NEWELL: It is still plastic, yes, sir.

QUESTION: Dr. Newell, you imply that possibly half of the other stars in the heavens have planetary systems. Isn't there any, at least, indirect way of finding out whether they have?

DR. NEWELL: Unfortunately, the planets generally are very small relative to the parent sun, so that their gravitational effects can be noticed very easily. And also, they don't shine by their own light, so that you can't see them.

QUESTION: Does Bode's law seem to explain the presence of the moon relative to the earth and, if so, why doesn't Venus have a large satellite?

DR. NEWELL: No, it doesn't seem to explain the satellites of the planets.

QUESTION: The moon is closest to the earth when it is between the earth and the sun. Why doesn't the sun pull it over so it is further away then?

DR. NEWELL: The moon is closest to the earth when --

QUESTION: What it is between the earth and the sun?

DR. NEWELL: Oh, well, what happens is, actually, we have the sun here (indicating), the earth here (indicating), and the moon going around the earth. First, then, if the sun weren't here, the moon would go around the earth in a perfect ellipse, relative to the center of the earth. Now, what happens with the sun here, is that as the moon goes here, the ellipse is elongated towards the sun slightly, and when the moon comes around here, it is flattened toward the sun slightly. But, inasmuch as the sun is pulling on both the moon and the earth and they both fall toward the sun, that is, they both go in an orbit around the sun, at about the same rate, the sun does not capture the moon. Now there is a distance between the earth and the sun at which, if the moon ever got there, the sun would take it.

QUESTION: This wasn't my question. The moon is closest to the earth.

DR. NEWELL: Yes.

QUESTION: When it is between the earth and the sun?

DR. NEWELL: Yes.

QUESTION: Now, why is this? You have indicated there that the moon would be drawn toward the sun a little more?

DR. NEWELL: Well, let me exaggerate it, the orbit of the moon now. It is elliptical. It is not a perfect circle. Now, as I have drawn it, it is perfectly true, that the moon is closest to the earth, when it is on the side toward the sun. But, what happens in the course of time is that this orbit of the moon precesses, takes 19 years for a full precession, nine years for a half precession and so this condition does not always hold. It varies. So there is nothing special about it, except that twice every 19 years this condition will persist.

MR. ROSEN: Gentlemen, we have been at this for an hour and 20 minutes almost. If you want to continue, fine. Shall we say, cut it off in about five minutes, or cut if off now?

QUESTION: Yes, Herb, are you going to have press kits now for release?

MR. ROSEN: Yes. Let's cut if off now.

Thank you very much.

(Whereupon, at 4:00 p.m. the conference was concluded.)

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D.C.

Hold for Release
5 p.m., December 3, 1958

Fact Sheet on the Transfer of Certain Facilities from Department of Defense to the National Aeronautics and Space Administration and NASA-Army Agreement on use of ABMA facilities.

The President's Executive Order issued today follows recommendations presented jointly by the National Aeronautics and Space Administration and the Department of Defense to the National Aeronautics and Space Council. The Order makes available to NASA additional capabilities to assist it materially in its task of conducting the nation's civilian space programs.

The Executive Order transfers from the Army to NASA the facilities of the Jet Propulsion Laboratory near Pasadena, California. In addition, NASA and DOD have agreed that, at NASA's request, the Defense Department will make available a portion of the research and development capacity of the Army Ballistic Missile Agency at Huntsville, Ala.

The Jet Propulsion Laboratory will continue to be operated by the California Institute of Technology, as contractor for NASA. Under the agreement, accompanying the Executive Order, Army projects now underway at JPL will continue under Army supervision until they are phased out largely during calendar 1959. These include work on the Sergeant missile and several smaller, classified projects.

The Jet Propulsion Laboratory was established prior to American participation in World War II. Pioneering work was performed on solid rocket propellants, and in addition, JPL scientists are recognized as leaders in electronics, communications and guidance used in space technology. The JPL facilities are valued at more than $55,000,000; more than 2,300 scientists, engineers and supporting personnel are employed at this research center.

Discussions between NASA and DOD over the transfer of facilities, began nearly 2 months ago. T. Keith Glennan, NASA Administrator pointed out that NASA, in order to discharge fully its responsibilities as set forth in Public Law 85-568, must develop at the earliest possible moment a capability for the effective handling of the functions connected with the design, development and use of satellite systems including propulsion units, guidance and control, scientific payload packages, and the acquisition and analysis of data of interest to both the scientific community and the Department of Defense.

In making his suggestion Glennan said NASA had assigned the highest order of importance to the avoidance of significant interference with the discharge of missions in support of the defense effort assigned to the separate installations by the several services.

He estimated that if NASA were to develop its own facilities to perform non-military space projects, there would be required an investment of more than $60,000,000, and the recruiting of a scientific and supporting staff numbering between 2,000 and 3,000. Building and staffing such a complex of space technology facilities would require from three to four years.

Deputy Secretary of Defense Donald A. Quarles, in the course of the discussions, informed Glennan that the Department of Defense agreed that the Army facilities at JPL could be transferred to NASA at once, but that it could not agree to the proposed partial transfer of ABMA to NASA.

The reason for the latter decision, according to Mr. Quarles, was that the Army is now engaged in development of missiles which are destined to play a very important part in the defense mission. The Deputy Defense Secretary further indicated that the unique capabilities of the ABMA team accordingly are essential to vital and high priority Department of Defense programs for the development of advanced military systems. However, he suggested, a portion of the capacity of ABMA could be made available for work on NASA space projects.

Glennan agreed to the Defense Department proposal, saying that for the present it provides a workable solution to NASA needs. Moreover, the NASA Administrator observed that every effort will be made to utilize the skills of ABMA to the maximum extent feasible.

The Department of Defense and NASA are agreed that within the next year, a joint report will be made to the President and the Space Council about the experience under the arrangements noted above.

- END -

PRESS CONFERENCE

BY

MR. ABE SILVERSTEIN
DR. WILLIAM H. PICKERING
DR. WERNHER VON BRAUN
DR. WILL KELLOGG

December 6, 1958

1520 H Street, N. W.

Washington, D. C.

3:15 a.m.

P R O C E E D I N G S

MR. BONNEY: Ladies and gentlemen, by way of opening this up let me make this one little informal statement. I am not sure what our technical panel has in mind because they are busy on other aspects of this shoot.

The question of the U. S. Air Force space probe tracking network has been in action in an informal way as a backup to the Army JPL tracking facilities. These include the Jodrell Bank dish at Manchester, England, the tracking station at Hawaii, and the long-range radar at Millstone Hill, New Hampshire.

This data, if they got any -- and we are not quite sure yet whether they did or not -- is being fed into Ballistic Missile Division facilities at Englewood, California, and from there is being transferred over to the jet propulsion laboratory data computing center at Pasadena.

With that little bit of prefatory I would like to introduce Dr. Abe Silverstein, who is NASA's Director of Space Fleet Development.

Dr. Silverstein.

DR. SILVERSTEIN: Tonight at Cape Canaveral was fired the payload designated Pioneer III. The firing was functionally successful. All four stages fired as was announced earlier. It is too early yet to tell how wholly successful the flight has been. However, it is clear at this time that the projection velocity was some 400 meters per second low, and the elevation three and a half degrees low.

Later this evening we will know more accurately after computations are completed at the jet propulsion laboratory computing center in California from the data coming in from the various tracking stations as to what the final apogee of the flight will be.

Now to tell you something about the Pioneer payload and the booster system which put it into the air, we have representatives here from Jet Propulsion Laboratory, the ABMA, and the IGY.

I would like to introduce first to you Dr. William Pickering, the Director of the NASA Jet Propulsion Laboratory, Pasadena, California. The Jet Propulsion Laboratroy was responsible for the upward stages and the payload system for the Pioneer III.

Dr. Pickering.

DR. PICKERING: The launching system for the Pioneer III was saddled with the Jupiter missile and we have at the extreme left a model of the complete Jupiter plus high speed stages. Dr. von Braun will tell us more about that in a minute. Suppose I start from the front end and go back.

We have here a model of the actual payload. This is complete with the electronics. The Geiger counter and so forth are all here.

The principal experiment conducted in this payload was to measure the radiation field between here and the moon with two Geiger counters which you see in the center. In addition to this there was an optical experiment which was essentially a so-called light trigger, optical trigger, which was to be triggered off if and when the payload got within a certain distance of the moon. I think that descriptions of the essential features here are in the handouts which you already have.

There was no attempt made to photograph the moon or anything of that sort in this first payload.

You notice the payload contains a break at this point which is the antenna gap so that the system then is radiating at this frequency of a little less than a thousand megacycles.

At launch the payload is spinning at about 400 revolutions per minute, and about ten hours after launch the spin is reduced to almost zero by a simple mechanism which is shown here which consists of two weights which spin off by centrifugal force and transfer the angular minimum of the payload to these weights so that the payload spin is reduced to a low value. This was planned this way because of the optical trigger and later experiments in which one might want to use a slowly spinning object to have a good look at the moon.

The radiation experiments, as I said, consisted of two Geiger counters. The experiment here was designed by Dr. van Allen at the State University of Iowa and is an extension of our developing information about the radiation belt which surrounds the earth.

We hope to have data which will take us through the radiation belt to get some idea of the maximum radiation observed as it goes through, and the rate at which it falls off as we get past the maximum.

This pay load, to continue the description, is mounted on the fourth-stage rocket, as you see in the other model here. The cluster of solid propellant rockets is very similar to what was used on the Explorer, mounted in a spinning top just as it was on the front end of the Redstone, except that this time it is on the front end of the Jupiter. You notice, also, that it is protected by a shroud in its passage through the atmosphere in order to protect the payload from aerodynamic heating in passing through the atmosphere.

The signals from this payload were tracked primarily from stations at Puerto Rico and at Goldstone, near Pasadena, California. At the Puerto Rico station there is a ten-foot tracking antenna. At Goldstone the 85-foot antenna is out on the desert.

At the present time, Puerto Rico is tracking the payload and has tracked it from shortly after launching. The motion of the payload across the sky, as observed from Puerto Rico, was from as appearing in the northwest in the direction of Cape Canaveral, then moving across the sky and going almost to the eastern horizon -- in fact, very close to the eastern horizon on this particular path. It is now beginning to rise again and we hope it will be tracked from Puerto Rico for several hours yet.

About the time that it begins to set in the west again, as seen from Puerto Rico, it will become visible from Goldstone, and we expect to track it then from the Goldstone station. At the present time, of course, the probe is not visible from Goldstone and it is just being tracked from Puerto Rico.

I think that that is perhaps enough to add to what is in the press handouts. I think now our plan is to have questions after this. We will have another statement or two and then we will have questions.

MR. SILVERSTEIN: The booster vehicle was done by the Development Operations Division at the Army Ballistic Missile Agency, the group from the Ordnance Command at Huntsville. This work was done under the direction of Dr. Wernher von Braun, who is here on my right now. I will defer to him.

DR. VON BRAUN: On this space probe we used a modified version of the Jupiter intermediate-range ballistic missile as the first stage.

Due to the fact that the cluster, the high-speed cluster array, is somewhat lighter than the standard nose section of a Jupiter, we put elongated sections somewhat and extended the burning time. The actual burning time of this particular configuration was in the order of 180 seconds.

Maybe I can explain with the aid of this model here, the main difference between this configuration and the standard Jupiter.

In the case of the standard Jupiter, we have this well-advertised nose cone here, and we just took this off and replaced it by the stool for the spin-up cluster with the JPL high-speed stages. In addition to this, we elongated this section to some extent.

Due to the much higher speed required for this flight, and the shallower flight path, we tilted much more rapidly to a near horizontal direction, and it was necessary to protect the high-speed stages in the entire front end of the missile from aerodynamic heating. For this reason a shroud was built to protect the entire cluster assembly during the first stage flight.

During those 180 seconds of booster flight path, the trajectory is tilted at an angle of nearly twenty degrees against the horizon, a very shallow angle at the end. After this we have a free-coasting time of approximately one minute until we fire the second, third, and fourth stages. During this one minute of free-coasting flight, the nose section is detached from the booster. We separate the unit at this point and there is an altitude-stablization system which aligns this entire front end, the guidance compartment and the speed-up launcher in the right direction in which the high-speed cluster is to be fired.

Of course, it is necessary to open up the shroud for the firing of the stages. Shortly after the main stage cut-off, we separate here and this unit is still on. This entire unit is altitude stabilized compressed air mozzles, controlled by compressed air in a line in which the exact stage is to be fired. We have a separation in which this nose cap is thrown off. This thrust is detached by igniting explosive bolts and a solid rocket kicks this whole thing over to the side so that the cluster itself can fire.

I forgot to mention that at the moment of separation another little solid rocket kicks this booster in a backward direction to build up some distance between this free-coasting nose section and the booster. We did this in order to avoid booster run-up with the nose section which occurred in one of our Explorer firings.

As far as the top stages themselves are concerned, it would be more proper if Dr. Pickering would explain this. With your permission, I suggest we switch again.

DR. PICKERING: Carrying on the description of the trajectory, then, after this separation has occurred, as Dr. von Braun indicated, then the high-speed stages are ready to fire. The cluster of high-speed stages first comes out of the tub in this fashion. And then after the firing of the second stage, the firing of the third stage will lift off this group of rockets, and then we have the firing of the fourth stage. So that makes the whole assembly.

Finally, of course, we separate the nose section from the last stage, and then the final operation is a de-spinning operation which slows down the payload. This means that out in space then the payload plus the last stage will be travelling along fairly close to each other, with the payload actually de-spun.

MR. SILVERSTEIN: I think it is very clear from the descriptions of the booster system and the payload that these missile rocket systems that are joined together with the payloads for space flights represent one of the highest levels of technical and scientific achievement. And the functional, the complete satisfactory functional operation of this complicated mechanism, as has been accomplished tonight, is indeed a supreme achievement in the engineering sciences and the arts.

The program on Pioneer III was managed by the National Aeronautics and Space Administration, which is under the direction of Dr. Keith Glennan. It was authorized by the President as a part of the work to be carried on under the International Geophysical Year -- the IGY program.

We have a representative here who is the Chairman of the Satellite Panel of the IGY, Dr. Will Kellogg. We will hear from him now.

DR. KELLOGG: I will make this brief because I know you want to get on to the question period. I would like to say, though, on behalf of the National Academy of Science and the IGY National Committee that we feel that this successful, from the scientific point of view, launching of a space probe which will go far out into the radiation belt above the earth will mark a very definite contribution to the International Geophysical Year. I think we can all be very proud of this contribution by the United States to the IGY.

MR. SILVERSTEIN: This is the end of the formal program. I will be happy to answer such questions as the panel here is able to.

QUESTION: Where does it look like it is going to go, Dr. von Braun or Dr. Pickering?

DR. PICKERING: We are not far enough along in our calculations yet. We do have a position shown on this sketch behind us, which is the position of the probe relative to the earth at 3:26 a.m., Eastern Standard Time.

QUESTION: Would you read those to us? We can't see them.

DR. PICKERING: X plus 2-1/2 hours, distance 22,000 miles; speed 7,834 miles per hour. That is 22,000 miles above the earth.

QUESTION: Does it look like it has enough velocity to orbit around the sun?

DR. PICKERING: No, the velocity will definitely not be enough to escape --

QUESTION: Can you calculate from this whether it will be enough to exceed the previous high altitude 79,000 mark?

DR. PICKERING: We do not yet know this. There are calculations being carried out now in Pasadena which are based on the initial readings taken from Doppler stations on the mainland and the tracking station at Puerto Rico. The data from Puerto Rico has been sent to Pasadena and calculations are being carried out at this time.

QUESTION: What went wrong?

DR. PICKERING: What went wrong?

QUESTION: Yes.

DR. PICKERING: You mean, why is the velocity low?

QUESTION: Yes.

DR. PICKERING: I think it is too early to say that. I don't know.

Wait a minute. Let me make a statement here as to what we know about the velocity at the moment. The velocity, as Dr. Silverstein said, is about 400 meters per second below the expected or hoped-for value, and it looks as though the path is about three degrees below the expected injection angle. That is to say, being launched about three degrees lower than it should have been.

QUESTION: Dr. Pickering, will you translate the 400 meters per second into miles per hour?

DR. PICKERING: Eight hundred miles per hour too low.

QUESTION: What was the program velocity?

DR. PICKERING: Again I have it in meters per second. I have it in miles per hour: About 21,000 miles.

QUESTION: Are these statute miles per hour?

DR. VON BRAUN: The program velocity was 24,897 miles per hour.

QUESTION: Was that at burn-out?

DR. VON BRAUN: At burn-out of the fourth stage.

QUESTION: At what altitude would that be?

DR. VON BRAUN: That is approximately 223 kilometers.

QUESTION: What kind of miles are we talking about, statute or nautical?

DR. VON BRAUN: Statute.

DR. PICKERING: You want the nominal injection velocity? Is that what you want first? The nominal injection velocity was 11,136 meters per second. If you convert that to miles per hour it is about 25,000. But on my six-inch slide rule at this hour of the morning I am not sure.

QUESTION: Dr. Pickering, Dr. Silverstein said the upper stages all fired perfectly.

DR. PICKERING: All stages. The question as to where the velocity deficit came from, we are not quite sure yet. There is some indication it may have been in the first stage. But I think this will need more analysis.

QUESTION: Dr. Pickering, how close had you planned to come to the moon, and how close have you come with this velocity with the angle you now have?

DR. PICKERING: I am sorry I can't give you the answer to how close we will come. If we had been within about 20,000 miles of the moon we would have been very happy. However, we certainly are low enough in velocity that the transit time out into the vicinity of the moon will of course be much longer than the planned time of 33 hours.

Also, I can say certainly we will not get as far out as the moon's orbit. Exactly how far out we will get I will just have to ask your indulgence and we will give you this as soon as it can be computed.

QUESTION: Dr. Pickering, do you think you will get further out than Pioneer II?

DR. PICKERING: I won't answer that question. I don't know. I just frankly don't know.

QUESTION: Do you have any idea how long it would take this vehicle to reach its apogee, its zenith?

DR. PICKERING: It will be several days.

QUESTION: Would that be say Monday or Tuesday?

DR. PICKERING: Again I will have to wait until we have more data. Let me tell you this: We should have this data in a few hours. We expect to hold another press conference at perhaps 8:00 o'clock in the morning.

QUESTION: Saturday morning?

DR. PICKERING: Saturday. At that time I hope we will have much more precise trajectory information than we have now. It is just too early to give you anything very precise.

QUESTION: Can you tell us what you will now find out, probably, with this trajectory and this distance in the way of information about the radiation belt and other things that you had intended to find out?

DR. PICKERING: Yes. The most important measurement that this instrument was to make was the radiation measurement. And this is being made.

QUESTION: I am sorry I couldn't hear you.

DR. PICKERING: The most important measurement which we expected to make was the radiation measurement. The telemeter data is being received. There is no time to look at this. But the information is that the telemeter data is very good. We hope we will get good radiation measurements for a considerable distance out between the earth and the moon.

It is expected by Dr. Van Allen that the maximum of the radiation belt will be reached somewhere perhaps less than

20,000 miles away from the earth. Therefore, we will certainly expect to go through the maximum and get good information on the radiation belt.

QUESTION: Will you find out as much with this trajectory the way it is working as you would have if it had worked the way you wanted it?

DR. PICKERING: Yes. From the point of view of the radiation measurement we will get practically all the data that we had wanted to get. In other words, it is not expected that the radiation intensity will change very much once we are perhaps 50,000 miles or so beyond the earth.

QUESTION: Are you going to be able to tell what kind of radiation it is?

DR. PICKERING: No, sir. This is a very simple measurement with Geiger counters.

QUESTION: So we won't know?

DR. PICKERING: We need much more elaborate equipment to give that answer. We may be able to deduce this information from an analysis of how the radiation behaves with respect to the magnetic field of the earth. But it will be an indirect measurement not a direct measurement.

QUESTION: In San Antonio Dr. Van Allen expressed the personal opinion that the radiation intensity might very well reach 100 Roentgen and they wouldn't be surprised at a thousand

Roentgen. I notice in the fact sheets you state that the maximum intensity these devices can record is 100 Roentgen per hour?

DR. PICKERING: That is true. This is an instrumental limitation. It may well be that the instrument will indicate that the intensity goes above that. If it does, this is useful enough. But it was a question of instrumental limitations and that is all.

I might point out that the data which has already been received at Puerto Rico has probably taken it through the maximum radiation belt. We are out here 20-odd-thousand miles and we are probably beyond the maximum now.

QUESTION: Dr. Pickering, what do you anticipate will happen to the payload after it reaches its farthest point, its farthest distance?

DR. PICKERING: From the apogee? It will fall back and probably fall to earth again. In fact, it certainly will fall to earth and burn up, of course, on re-entering the atmosphere.

QUESTION: There is no chance of it going into orbit around the earth?

DR. VON BRAUN: The perigee is lower than the injection point.

DR. PICKERING: No, it will not.

QUESTION: Why?

DR. PICKERING: Because it is launched above the horizontal. If it had been launched horizontally it would have been into it. But it was launched appreciably above horizontal.

QUESTION: What is the difference in the Geiger counters in range?

DR. PICKERING: one of these Geiger counters is a counter which counts every particle which passes through it. The other is a Geiger counter which has been modified to measure much higher counting rates than the normal Geiger counter.

The standard Geiger counter, in other words, will saturate at fairly low radiation levels. The second instrument here will carry it on up to about 100 hours.

QUESTION: What is the range?

DR. PICKERING: About ten hours.

When one is quoting figures, this is a little deceptive because it depends on what you assume about the nature of the radiation, as to how many particles are involved.

QUESTION: Ten in a hundred is based on what?

DR. PICKERING: Electrons.

QUESTION: Dr. Pickering, was your burn-out speed of 24,987 miles per hours, the program speed, sufficient for earth escape velocity?

DR. PICKERING: The program burn-out?

QUESTION: The program burn-out velocity.

DR. PICKERING: This would have taken us out to an orbit, which would have had a perigee well beyond the moon. Let's put it that way.

QUESTION: Do you mean apogee?

DR. PICKERING: I am sorry.

The answer to your question is Yes, it would have gone out into an orbit around the sun.

QUESTION: Because it came close enough to the moon to flip it or something?

DR. PICKERING: No.

QUESTION: Could you explain the mechanics of that?

DR. PICKERING: Just that it went fast enough to get away from the earth and not return to it.

QUESTION: Then it did reach escape velocity?

DR. PICKERING: Yes.

QUESTION: Did you put a margin of safety into this safetywise?

DR. PICKERING: Margin of safety to reach the moon, yes. For escape, yes, there is a small margin for escape. I don't know what the minimum is for escape. It is roughly about a 300-miles-an-hour margin above escape velocity.

QUESTION: Dr. Pickering, I am sorry, I came in late. I heard you say as I came in that it would fall back to earth. What happened?

DR. SILVERSTEIN: I think we ought to repeat these questions because some are not hearing them in the back of the room.

DR. PICKERING: The gentleman said he came in late and he heard me say it would fall back to earth and he wants to know what happened. The answer is that the velocity which had been attained was about 400 meters per second below the expected escape velocity which we had planned for.

QUESTION: Which was?

DR. PICKERING: This, then, will put it into an elliptical orbit which will have an apogee somewhere between here and the moon or the moon's orbit, and which will therefore return back to earth.

QUESTION: How much could you have missed by and still have reached the moon as far as velocity is concerned?

DR. PICKERING: The minimum velocity to reach the moon is about --

DR. VON BRAUN: Why don't we read off the figure we have here? This is meters per second again.

The design speed that we are shooting at was 11,136 meters per second. This would have put the fourth stage into an escape hyperbola which would have passed the moon after about 34 hours transit time.

The minimum speed to reach the moon at all would be 10,840 meters per second, which is approximately 300 meters per second less.

With this minimum speed the rocket would have gone into an ellipse -- not an escape hyperbola but an ellipse with the apogee into the moon's orbit, and the transfer time would have been to 100 hours. This is the minimum speed it takes to carry the rocket out to the moon's orbit.

The actual speed was not 300 meters per second shy with respect to the design escape speed but 376, or not quite 400 meters. This is a preliminary figure.

DR. PICKERING: As a preliminary guess then we are about 100 meters per second too slow to carry the apogee to the moon.

DR. VON BRAUN: This is very sensitive.

DR. PICKERING: The actual apogee altitude is very sensitive to this. These are initial calculations. As more data come in these will be refined.

QUESTION: Velocity to go out into orbit around the sun, the minimum velocity?

DR. VON BRAUN: That is the escape velocity. Anything leaving the rotational field of the earth goes automatically into orbit around the sun.

QUESTION: What was the design velocity?

DR. VON BRAUN: Design velocity would have provided escape.

DR. PICKERING: Design velocity was roughly about 160 meters a second above escape velocity.

QUESTION: 11,286?

Do you know yet which stage it was?

DR. PICKERING: Maybe we should put some numbers on the board. We will give you meters per second because it is tabulated that way.

These figures, for those of you who are mathematically inclined, are in the space-fixed Gordon system and for launching across approximately this trajectory.

QUESTION: What are these figures in?

DR. PICKERING: Meters per second.

I would like to emphasize again that this last figure is a preliminary figure.

QUESTION: What did you say the conversion factor is? 2.2 to miles?

DR. PICKERING: I beg your pardon?

QUESTION: Is the conversion factor 2.2 to miles?

DR. PICKERING: That is what Will tells me.

Are those statute miles?

DR. KELLOGG: Nautical miles per hour.

QUESTION: 2.2 is to nautical?

DR. KELLOGG: I believe if I remember right that is conversion to nautical miles.

Why don't we leave it at meters per second?

DR. PICKERING: It is a good exercise for you. We school teachers say it is a good exercise for students.

QUESTION: What was the total powered flight, total time?

DR. PICKERING: The total time of powered flight was about three minutes for the first stage and each of the other stages. The combined time for the other stages is about half a minute.

MR. SILVERSTEIN: Gentlemen, I think we have had a considerable period of questions here. We will have a few more and call the session closed. Suppose we have three more questions.

QUESTION: Can you tell us something about the photoelectric scanning mechanism and the purpose of that experiment?

DR. PICKERING: It is hoped that later moon probes will give us pictures of the moon, and this particular probe is a simple photoelectric switch, one might call it, which was designed to operate an optical system in a later probe so that when the probe reached the vicinity of the moon the camera system, whatever it may be, could be turned on to take the necessary pictures. In order to turn it on, then, you need something that says the moon is now inthe field of view. This is just a simple photoelectric device which tells you that at that particular instant of time the probe is looking toward the moon; that is all.

QUESTION: Will you get a telemetered signal back when it turns on?

DR. PICKERING: Yes.

QUESTION: Or you would have?

DR. PICKERING: We would have, yes.

QUESTION: But if it doesn't come close enough, you won't?

DR. PICKERING: That is right.

QUESTION: Why didn't you use a scanner? Is it too heavy? A ground scanner.

DR. PICKERING: Why didn't we take photographs? This experiment was a simple experiment, first to test out the system and to perform this radiation measurement.

QUESTION: How close would this one have to come to trigger?

DR. PICKERING: About 20,000 miles.

QUESTION: What did you do to prevent the sun from triggering it?

DR. PICKERING: It is pointed in such a direction that it will not look at the sun. You see, it is stablized in direction. The problem is to prevent the earth from triggering it. And this is not activated until it gets a long way from the earth.

QUESTION: Are you sure you can call this probe a success?

DR. PICKERING: It is obviously not a hundred-percent success. From a scientific point of view, it is very close to being a hundred-percent success. From the engineering point of view, we did not attain all of our objectives.

MR. SILVERSTEIN: Gentlemen, those are our three questions.

We will hear from Mr. Bonney now.

MR. BONNEY: First, I will dare to give you a conversion factor on this meters business. If you take a thousand meters, you have one kilometer, and one kilometer is .621 miles.

I will repeat that. A thousand meters is one kilometer, is .621 miles.

While this conference was going on I was on the hot line to the Cape. One thing, I think, that we didn't do here sufficiently and Dr. Glennan did very emphatically down at the Cape was to extend his very sincere thanks to the Army team, to the team at our new NASA Jet Propulsion Laboratory at Pasadena, and to the scientists who provided the instrumentation that went into Bill Pickering payload.

Finally, we think we can give you a considerably more accurate account of what the apogee is likely to be about eight o'clock this morning. If, however, some of you sleepy-heads would rather make it nine o'clock, we will be happy to oblige. I would like to take a voice vote.

All in favor of eight?

All in favor of nine?

We will settle for nine o'clock. We will reconvene at nine o'clock, gentlemen.

DR. PICKERING: This is a final comment. At that time the Goldstone station, of course, should be tracking the probe.

(The conference was concluded at 4:00 a.m.)

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The Challenge of the Space Age

by

T. Keith Glennan, Administrator
National Aeronautics and Space Administration
Annual Banquet, Fort Worth Chamber of Commerce
December 8, 1958

It is a very real pleasure being with you tonight. I seem to feel very much at home with the folks I have met here in Dallas. Certainly, I can make no claim to a Texas birthright. But perhaps my Middle Western background gives me a sense of kinship with your own heritage of hard work and drive.

Fifty years ago, my Dad was a member of the elite of American workmen. He was one of many men whose job and privilege it was to keep the railroad trains running ... at all costs ... in times of blizzard and in times of flood. At home we learned quickly some of the facts of life that you Texans know so well: When a man has a job to do, he does it ... He rolls up his shirt sleeves and his sweat helps him get the job done.

We at NASA have been given a big job -- planning and executing the nation's civilian space program. But before talking about some aspects of our task, I would first like to dispose of a question that is asked of me quite often: Why venture at all into the unknown, towards the moon, the planets and then towards the stars so far beyond? One answer was given by Tsiolkowsky, the 19th century scientist whom Russia considers the grandfather of space travel. It was that, "the earth is the cradle of the mind, but one cannot live forever in a cradle."

Another, simpler way of answering that question is to say that man always has had his eyes fixed upon the stars. Now, for the first time, he has the ability to take his first faltering steps toward those goals. And because we are the way we are, there will always be those among us who will venture off, to seek our El Dorados in the sky.

But don't be misled. "The thrust of curiosity that leads man to try to go where no one has gone before" by itself isn't reason enough to justify the expenditure of the hundreds of millions that such ventures into space will cost. There also must be a payoff -- to the American taxpayers who are footing the bills.

Scientists are satisfied with the idea of searching for new knowledge for its own sake. Actually, there is a great deal of evidence in history to prove the thesis that the scientific progress made in this fashion has provided great benefits to mankind that were undreamed of by the scientists themselves.

As realists, we have to be interested at least equally in the early and direct benefits which we may anticipate from our investments in space technology. We have to think about what will result of value to the people who are now alive -- people like us here tonight. A little later, I shall discuss some of the prospects we may expect in the years immediately ahead.

One year ago this week, the United States made its first attempt-- two months after the first Russian success--to launch a man-made satellite. A day or two later Marguerite Higgins, the well-known news correspondent, asked a question, more pointedly than most of us had phrased it: "If our Vanguard's failure is considerably less than fatal, and if Russia's Sputnik was something less than totally decisive, the question remains as to why these events set off such shock waves throughout the world and particularly in America."

There have been, of course, almost as many responses to that comment as there have been thinking people. In the past 12 months, we in the United States have made a soul-searching re-examination of our course and our destiny. Much good has come from this great appraisal of where we stand in the world of science, and more particularly, where we stand in space technology. Perhaps equally important, we have done more than just think and talk.

Let me review quickly some of the events of the past year, as President Eisenhower and the Congress -- with Senator Lyndon Johnson especially providing signal leadership -- moved quickly.

One of the first actions by the President was to appoint James R. Killian, Jr., president of M.I.T., as his special assistant for science and technology, and to direct him to come forward with recommendations for whatever action was necessary. In both the House and Senate, special committees studied the question of what our nation should be doing in space matters.

We quickly stepped up our programs of space experiments. The Army undertook a series of Explorer satellite launchings, and, a little later, the President directed the Air Force and the Army to fire instrument packages into space in the neighborhood of the moon. Note, I have chosen my words carefully...we were not seeking to hit the moon. Rather, we wanted to send our instruments as far as the moon, and even beyond...obtaining data all the way on those voyages of nearly a quarter million miles. In addition, and here we were admittedly being extraordinarily sanguine in view of the state of the technology, we hoped to put some of our space probes into orbit around the moon. We hoped to get a rudimentary picture of the back side of the moon and to telemeter it back to earth.

The Advanced Research Projects Agency was established within the Department of Defense, to give technical direction to military space activities. In addition to its military assignment, ARPA was given initial responsibility for technical direction of civilian space activities, until such time as the necessary new organization had been completed to undertake that responsibility.

In March, the President sent a special message to the Congress, calling for establishment of the National Aeronautics and Space Administration. Perhaps the most significant single thought in the National Aeronautics and Space Act of 1958 which resulted is the one embodied in the statement, and I quote, "It is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind." The national decision that is explicit in this statement will, I believe, be long remembered as a tremendously important step forward in man's struggle to rise to a state of maturity and real civilization.

This national position is so important, I should like to quote briefly from comments about it by your own Senator Johnson last month before the United Nations. I quote Senator Johnson not only because his part in the passage of the Space Act was so significant, but also because his remarks have the ring of eloquence that comes from earnest conviction. He said:

"On the goal of dedicating outer space to peaceful purposes for the benefit of all mankind, there are no differences within our Government, between our parties, or among our people. The Executive and the Legislative Branches of our Government are together. United we stand.

"The very opportunity of the issue...is to erase the accumulated differences of our earth's long and troubled history and to write across the vastness of space a proud new chapter of unity and peace.

"It is the American vision, I believe, that out of this fresh start for humankind which space affords, man may at last free himself of the waste of guarding himself against his ignorance of his neighbors. Barriers between us will fall as our sights rise to space. Secrecy will cease to be. Man will come to understand his fellow man -- and himself -- as he has never been able to do. In the infinity of the space adventure, man can find growing richness of mind, of spirit, and of liberty."

As Americans, we can be proud that our country is leading, and in fact for nearly a year, has led in the effort to establish a workable system that will give meaning to the principle that space flight is, or at least should be, inherently international. That such cooperation in scientific effort at the international level can be had has been amply demonstrated by the success of the International Geophysical Year activities which have occupied the attention of thousands of scientists all over the world for the past eighteen months. We seek to extend that cooperation, so well begun in the IGY, to the exploration of outer space for the benefit of humanity.

There can be no quarrel, of course, with the idea that such use of space as may be required for national defense is and must remain a responsibility of the Department of Defense. That premise is spelled out in the Space Act. It is stipulated that matters of proper military concern include, and I quote: "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the Defense of the United States)."

In some areas of space activity, there is a duality of interest. This fact was also recognized by the law makers, and the House Space Committee commented about it as follows:

"Although weather and communications satellites, manned platforms, and the like have obvious military uses, their primary purpose should be declared civilian. If we do not do this, we automatically commit the world of the future to the same stalemated life in armor which is lived by the world of today. If the very efficiency of current weapons virtually denies the practicable possibility of total war, further strides made in our rocket development would probably intensify this denial... The entire purpose of our effort should be to insure that the peaceful uses of these devices prevail. This is the stated philosophy behind our space exploration. It is the philosophy of this country."

Under our democratic system of government--I should like to interpolate that I am sure that for us, it is the very best form of government--it sometimes seems as if the lag between ideas and accomplishments is unnecessarily long. But if that time is well used to think through all the related problems, then it is not time wasted.

The Space Act was passed late in July and the President signed it on the 29th of that month. He appointed me on August 8, and, after confirmation by the Senate, I was sworn in on August 19. Because I had unbreakable commitments with respect to the impending beginning of a new school year at Case, I was unable to check in at NASA headquarters for full-time work until September 9.

It seems hardly possible that it won't be until tomorrow that the first three months of this new adventure have been completed. In many ways, it seems as if NASA had always been in business!

One big reason why we are now traveling ahead at nearly full steam is that the NASA is built upon the structure of the National Advisory Committee for Aeronautics...which from 1915 until October 1 of this year was the nation's aeronautical research agency. From NACA we got nearly 8,000 hard-working, talented people; we got $300,000,000 in research facilities; we got well-planned research programs already underway.

Soon after I came on the job, I addressed the former NACA employes. I told them that NASA's scope was much broader, and that its objectives were much greater, than those of NACA. For example, the admittedly vital functions of NACA...research into the problems of flight...are only one part of NASA's activities.

NASA's job was to broaden and extend the excellent team-work relationships NACA enjoyed over the years with the Military Services and the airplane-missile-space industry. Again, I digress to say that NACA had the most useful and friendly relationships with organizations like Convair-Fort Worth, Chance Vought, and Bell Helicopters, to name just three of the area companies that are working in the fields of flight. Earlier today, I had a chance to look at the B-58 production lines with my good friend and former Yale classmate, Augie Esenwein, and once again, I was reminded of the wonderful reputation NACA earned over the years...a reputation resulting from such pioneering developments as the "area rule" and the conical camber principle that are incorporated with useful effect on the supersonic B-58 Bomber.

NASA obviously has to add new and extremely able people to the staff, to develop capabilities in fields other than those where NACA was strong. These needs, in addition to our determination to avoid unnecessary expenditures for facilities which would duplicate others already in existence and to avoid the inevitable competition for personnel necessary to man new facilities, led us to seek out an arrangement with the Defense Department whereby certain laboratories and personnel might be made available to us at an early date. As you doubtless know, these negotiations were completed last week with the transfer of the Jet Propulsion Laboratory in Pasadena to NASA and the signing of an agreement relating to the use of a portion of the capabilities of the Army Ballistic Missile Agency by NASA. The latter group will remain under Army direction but will be responsive to the needs of the NASA managed civilian space program as may be required.

We are now administering substantial programs of research, development, and procurement with others on a contract basis. We will be spending large amounts of money, outside the agency, by contracts with scientific and educational institutions and with industry. We are using other facilities of the Military Services, such as the launching pads at the Atlantic and Pacific Missile Ranges. We have to collect great masses of scientific data, and we have to reduce this information into useful form.

We are in the business of developing and launching into space vehicles needed to obtain scientific data...we are in the business of exploring the solar system. We are preparing for the day of manned flight into space.

Now...getting back to the pay-off. I can tell you of a couple very obvious uses of satellites and space platforms...ones that offer very direct and immediate pay-off possibilities.

One of these, of course, has to do with meteorology. Dr. Francis W. Reichelderfer, Chief of the U.S. Weather Bureau, estimates the value of the more accurate, longer range weather forecasting and storm warnings that we can expect to attain from good use of space technology will be several billion dollars a year.

Over the years, great progress has been made in this direction, but there are definite limits to what we can hope for in weather prediction so long as our observations must be made entirely from within the earth's atmosphere. One example is the way the behavior of the air masses over the oceans often determines the weather over the inhabited land masses. These great areas of water, as every schoolboy is taught, cover more than two-thirds of the earth's surface. We know so little about how the world's weather is generated over these vast ocean masses and over the polar areas that we are unable to forecast the resulting weather accurately. This is particularly important in the case of devastating typhoons and tornadoes. We have made some progress in our aerial study of hurricanes that form in the Caribbean, but the cost to expand this kind of effort around the world would be great, and the information obtained insufficient to warrant the added cost.

With properly instrumented satellites, the meteorologists can watch storms form and move and disappear, all around the world on a 24-hour basis. They can study also the physical processes that <u>make</u> our weather...how the earth's surface absorbs heat energy from the sun in varying amounts, and how the heat circulates unevenly between the equatorial and polar regions. By observing, measuring, and then understanding these complicated heat-transfer processes, the meteorologists expect to be able to predict normal and abnormal weather, including the onset of destructive droughts, catastrophic windstorms, and flood-producing rains. Beyond all this, they dare dream about the day when, finally, they will have fully comprehended the meaning of their new knowledge, and may then be able to an extent, to modify the weather. Dr. Reichelderfer's calculation of several billion dollars a year was premised on the value of more accurate, longer range weather and storm forecasting. The value of weather control would be incalculable.

The use of satellites in communications also offers the prospect of great advantages and economies. In this area, I can report, there is such keen interest that several of our most profit conscious electronics companies are spending money of their own to insure if possible that they have the competence to insure their participation in such satellite operations. Dr. Wernher von Braun, director of the Development Operations Division of ABMA at Huntsville, Alabama, estimates that the use of man-made satellites to transmit commercial messages and TV programs on a global basis will be not only commercially practicable but will, and I quote, "pay for trips to the moon and other ventures in this business."

But what of the longer pull? What is the payoff prospect there? Let us face the fact that the space bill will be one that is counted, year after year for a long time to come, in the hundreds of millions of dollars. Unfortunately, as Norman Cousins has pointed out, this activity will take its toll of young lives, as well. I don't know all the good that will result, and I doubt if any man alive today can give really specific answers.

But in this connection, I am reminded of the story they tell about Michael Faraday, the English physicist, whose pioneering work in electro-magnetics had such a profound effect upon our later understanding of electro-dynamics leading to the development of useful electric power. It was about a hundred years ago that Mr. Faraday is supposed to have been asked, in the British Parliament, about the value of his electro-magnetic experiments. His answer, so the story goes, was, "I can't tell you what it'll be good for. But I'll tell you this: One of these days you'll be taxing it."

And, by way of conclusion, I'd like to quote another very wise man...a member of the President's Space Council and my valued friend ...Jimmie Doolittle:

"I can't tell you precisely what of great value will come out of our moving into space to probe the secrets of the universe. However, I have the conviction, and in this I find myself in the company of some very wise men, that a century from now, perhaps much sooner, people will say that this venturing into space that we're planning now was one of the most practical, intelligent investments of our national wealth to be found in history. If we in the United States take the wisely bold action necessary to lead in exploiting the possibilities of space technology for science, all mankind will benefit."

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

FOR RELEASE:
Wednesday, 10:30 a.m.
December 17, 1958

NASA ACCEPTS ROCKETDYNE PROPOSAL FOR LARGE ROCKET ENGINE

The National Aeronautics and Space Administration has selected Rocketdyne, a division of North American Aviation, Inc., Canoga Park, California, as the source for design and development of a rocket engine in the one to one and one-half million pound thrust class. The negotiations for a formal contract with Rocketdyne will open early next month.

Six companies submitted proposals in the NASA competition for the large rocket engine project. The selection of Rocketdyne, according to T. Keith Glennan, NASA Administrator, was based on a careful assessment of the technical value of the proposal, and of the facilities, experience and other qualifications of the company.

The NASA initiated the competition three weeks after the agency was given the responsibility for development of the high-thrust engine on October 1 by President Eisenhower.

The NASA's long-term big engine program may require a period of from four to six years to bring it to useful completion, Glennan said. In addition to the design and development of the engine, the program includes the use of Government facilities and test stands to be constructed at Edwards Air Force Base, California. It further includes Government-furnished fuel for testing components as they are developed. It is expected that the total cost of the program will exceed $200 million.

The engine -- designed to deliver far more thrust than any other rocket now in existence -- will be used to advance U.S. exploration of space.

Credit for the speed in evaluating the proposals, Glennan said, goes to the scientists, engineers, and administrative officials of the NASA and the USAF Wright Air Development Center, Air Research and Development Command.

Abe Silverstein, NASA Director of Space Flight Development, described the engine as a liquid bi-propellant, single chamber, booster rocket of 1,000,000 pounds nominal thrust, and capable of being developed to 1,500,000 pounds thrust. He said it will use liquid oxygen and hydrocarbon propellants but will be designed for other liquids without major change. Special attention will be devoted to methods of simplifying directional thrust control and of pressurizing propellant tanks.

Under Silverstein, the project will be managed by Abraham Hyatt, NASA Assistant Director of Propulsion Development. Adelbert O. Tischler, Chief of Liquid Fuel Rocket Engine Programs, will be the principal project officer.

NASA officials said the program will provide a simple, dependable booster of great size. It will be used to launch into space payloads and experiments weighing as much as several tons. Performance flight rating tests of the engine will be based on unmanned vehicle applications but it may eventually propel manned satellites and space craft.

Rocketdyne was established as a separate division of North American Aviation, Inc., in 1955 to perform research and development work on rocket engines and propellants. The parent company initiated its rocket engine work soon after the end of World War II.

- END -

SOME RESULTS FROM THE PIONEER III FLIGHT

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On December 6, at 5:45 Greenwich Mean Time, the latest attempt to send an instrumented vehicle to the vicinity of the moon began with the successful launching of the Juno II missile system.

The launch was conducted for the National Aeronautics and Space Administration by the Army Ballistic Missile Agency and the Jet Propulsion Laboratory of the California Institute of Technology.

The purposes of the experiment were to establish the trajectory, to measure radiation intensity with particular attention paid to measurements of the so-called Van Allen radiation belt, to test the long range communication system, to test the launching vehicle, and to test a de-spin system and a light sensor.

As is well known by now, the payload failed to attain escape velocity and reached an apogee of 63,580 miles. While the results of the launch were disappointing in that sense, the dividend of radiation measurements of the Van Allen belt gained as the payload returned to earth were of great value in defining this energy field.

Tracking of telemetering during the flight of Pioneer III was accomplished at three different locations separated from each other by thousands of miles.

The first station was a simple telemetering receiving station located at the launch site on the Atlantic Missile Range, Cape Canaveral, Fla. The function of this station was to receive telemetering until the probe vanished over the local eastern horizon.

In the launching trajectory that was chosen, the probe disappeared over the eastern horizon from the launch site approximately 15 minutes after launch. It was not expected to reappear on the horizon until almost 90 minutes after launch when the eastern rotation of the earth returned it to view.

During the time the probe was lost to sight at the launch site, it would be passing through the Van Allen radiation belt. Since measurement of this belt was one of the prime missions of the flight, it was necessary to establish a second telemetering station--this one located at Mayaguez, Puerto Rico, approximately 1000 miles southeast of the launch site.

The Puerto Rico station used a 10-foot diameter antenna operated in a fully automatic tracking mode. Phase lock receivers were used both for tracking and telemetering. The slant range at which this station could receive good quality telemetering was approximately 50,000 miles.

The Puerto Rico station acquired Pioneer III approximately five minutes after launch and tracked it until the next station in the sequence--(Goldstone Tracking Station, north of Barstow, Calif.)--reported full acquisition and tracking.

Goldstone Tracking Station is an 85-foot diameter antenna located in a remote part of the California desert. The tracking characteristics of the two stations are shown on these slides:

	GOLDSTONE	PUERTO RICO
Transmitter carrier power	96 MW-19.8 dbm	96 MW-19.8 dbm
Vehicle antenna gain	2.5 db	2.5 db
Space loss at	-204.5 db at 250,000 miles	-190.5 db at 50,000 miles
Net ground antenna gain	39.4 db	21.5 db
Received signal	-142.8 dbm at 250,000 miles	-146.7 dbm at 50,000 miles
Receiver threshold	-153.5 dbm	-153.5 dbm
S/N for RF loop (20 cps BW)	10.7 db	6.8 db

After acquiring Pioneer III five minutes after launch, Puerto Rico tracked for eight hours in a fully automatic mode. The angular position of the antenna was sent to the Jet Propulsion Laboratory in Pasadena, Calif., by teletype every 10 seconds. Three channels of telemetering were read out continuously on the magnetic tape and onto direct writing oscillographs. Continuing verbal reports were sent to both the launch station and to Goldstone. It was during this time that the complete description of the Van Allen radiation belt was obtained.

There were, however, some anxious moments at the Puerto Rico station. Because of the non-standard trajectory of the probe, the signal very nearly was lost as Pioneer III came very close to disappearing over the horizon at Puerto Rico.

Under normal circumstances, it was not anticipated that the probe would come closer to the horizon than seven degrees. The Puerto Rico station had been designed so that the beam width of approximately ±4 degrees was a compromise between the effective range of the system and the angular position above the horizon.

The flight of Pioneer III, however, came within 2.3 degrees of the horizon before the eastern rotation of the earth made it appear as if the probe was again climbing in the sky. It was at about this time that the probe was passing through the most interesting part of the Van Allen radiation belt, and despite its close approach to the horizon, the Puerto Rico station was able to continuously receive information from it.

As mentioned before, Puerto Rico sent periodic reports on angle and velocity to the Jet Propulsion Laboratory, where the necessary calculations were made to enable the Goldstone Tracking Station to acquire the signal.

These calculations were necessary because the Goldstone station uses a beam width of a fraction of a degree, making it difficult to find the probe without prior information as to probe position. The pencil beam width also makes it possible to track to a range of 500,000 miles.

Goldstone acquired Pioneer III seven hours after launch and tracked and received telemetering until it fell below its horizon. Had the trajectory been nominal, Goldstone would have been in position to track once again as Pioneer III neared the vicinity of the moon.

But because escape velocity was not reached, Goldstone was not in a position to track any part of the descent. Fortunately, however, Puerto Rico was able to reacquire at 6:51 a.m. (EST) on December 7 and track and receive telemetering until the probe fell below the Puerto Rico horizon. At that time, the probe was at an altitude of approximately 2500 miles. It continued on into the earth's atmosphere and incinerated at 16.4 degrees north latitude and 18.6 degrees east longitude, over French Equatorial Africa.

The conclusions drawn from this phase of the operation are that the Goldstone system is capable of acquiring and tracking space vehicles and that Puerto Rico is capable of tracking to its design threshold of 50,000 miles. What remains to be tested is the behavior of the 85-foot Goldstone antenna near threshold.

Turning to the other phase of the experiment, let us examine the instrumentation in the Pioneer III probe.

Here we see a slide of the payload in cross section with the final stage attached.

There were three experiments monitored during the flight, using an FM-FM telemetry system. Two of the three experiments were alloted 14 milliwatts and the third 36 milliwatts. Dr. Van Allen of the State University of Iowa has already described the radiation experiment and its results, so this effort will describe the two experiments for which JPL was responsible--the temperature control study and the de-spin and optical trigger mechanism.

Since the upper stages of the launching vehicle were spin stabilized during the launch phase, the payload continued to spin in space at a rate of 400 rpm.

The optical trigger was contained in a pistol shaped instrument mounted on the bottom of the probe at an angle so that it would have commanded a view of the moon as the probe moved past the moon.

Inside the barrel of the pistol are two small aperatures opening into two photoelectric cells. The aperatures are spaced so that only a comparatively large light image would have been able to enter both and trigger both cells simultaneously.

A hydraulic timing device aboard the payload was designed to perform two functions: slow the de-spin rate from 400 rpm to six rpm at 10 hours after launch and arm the optical trigger 20 hours after launch.

It was necessary to sharply reduce the spin rate in order to give meaning to the optical trigger data.

At 10 hours after launch, the timer was to have operated the de-spin mechanism. This consisted of two counterweights, each weighing six grams, which were fastened to the payload at the ends of wires 60 inches long. During and after launch, the wires and weights were wrapped around the payload and secured in place.

When they were released, according to the plan, they were to have caused the spin rate to slow down to six rpm.

The de-spin mechanism failed to operate, although the timer which was to trigger it is known to have been functioning since it did arm the memory circuit in the optical sensing experiment. This shows up on the telemetry tapes.

The optical trigger experiment was to provide a test for a trigger device that could be used to activate a television camera in future space experiments.

In the Explorer satellite series, JPL developed a temperature control method to protect the heat sensitive electronic components in the satellite payload. This was done by coating the exterior of the payload with zirconium oxide in order to control the heat absorptive and radiative effect and stabilize the interior temperature.

This same system was used to control the interior temperature of Pioneer III. Over the gold surface of the payload, a black and white paint pattern, in a varied stripe design, was applied. The proportion of painted surface varied from about 15 per cent to about 44 per cent on various surface sections.

Aim of this experiment was to keep the interior temperature within 10 to 50 degrees Centigrade. Median temperature was 37 degrees over most of the flight.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

December 7, 1958

For Immediate Release

Time: 4:00 p.m.

No. 19
EX. 3-3260
Ext. 6325

Statement by NASA

The United States space probe PIONEER III reentered the atmosphere and burned up due to aerodynamic heating at 2:51 p.m. EST, December 7, 1958, after a flight of 38 hours, six minutes, The National Aeronautics and Space Administration announced today.

The probe was launched from Cape Canaveral, Florida, at 12:45 a.m., December 6 to conduct these experiments:

1. Cosmic radiation measurement
2. Evaluation of the Goldstone and Mayaguez Tracking Station
3. Evaluation of a photographic trigger sensing mechanism to be included in future space probes.

Following is a summary of the major statistics of PIONEER III:

TIME IN FLIGHT: 38:06 hours
TIME OF REENTRY: 2:51 p.m. EST, Dec. 7, 1958
VELOCITY AT REENTRY: 23,000 MPH plus
ALTITUDE WHEN BURNED OUT: 55 miles (approx.)
POINT OVER EARTH WHERE BURNED OUT: 16.4° north latitude, 18.6° east longitude. (over French Equatorial Africa, South of Libya)
TIME USABLE TELEMETRY DATA RECEIVED: 22 hours (approx.)
APOGEE: Approx. 63,000 miles above the surface of the earth
MAXIMUM VELOCITY: 23,900 miles per hours

It will be some time before data received by tracking stations can be analyzed and findings determined accurately. The Jet Propulsion Laboratory, Pasadena, California, reported excellent data signals have been received by both Goldstone and Mayaguez Tracking Stations.

No observation reports have been received. However the Puerto Rico Tracking Station was in contact until the probe radio signals were blocked when the probe fell below the horizon at Puerto Rico.

END

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

December 7, 1958

For Immediate Release

Time: 4:00 P.M.

No. 20
EX 3-3260
Ext 6325

STATEMENT BY DR. WILLIAM H. PICKERING, DIRECTOR, JET PROPULSION LABORATORY, Operated by California Institue of Technology for National Aeronautics & Space Administration

PIONEER III which re-entered the earth's atmosphere at approximately 2:51 P.M. (EST) today provided us with an unexpected dividend of information of great value.

The Puerto Rico Tracking Station was in contact with PIONEER III from the time it acquired it for the second time this morning at 6:51 A.M. (EST) until it fell below the Puerto Rico horizon on its long journey back to earth. Puerto Rico lost the signal from the probe at approximately 2:30 P.M. (EST) when it was approximately at 2000 miles altitude above the earth over French Equatorial Africa.

This means, of course, that the telemetery from the probe was heard by Puerto Rico as the probe passed through the radiation belt discovered by the explorer satellites. The telemetry tapes from Puerto Rico for both the launch and the trip back to earth show solid data which will give us, for the first time, information as to some of the energy levels in the radiation belt as well as some idea of the physical limits of the belt.

While the results of the launch of PIONEER were disappointing to the engineering specialists in that the probe did not reach the moon, the scientific benefit to be obtained from this dividend of two long instrumented passes through the Van Allen radiation belt more than compensates for this disappointment.

I am greatly pleased with this significant result of the experiment, as well as by the evidence that the tracking network proved itself most efficiently. The large computer at the Jet Propulsion Laboratory in Pasadena was able to predict most accurately the time and place when PIONEER III would rise like a star on the horizon so that the tracking antenna at Goldstone and Puerto Rico could be positioned to receive the signal.

Telemetry also shows that the method used by JPL to control the interior temperature of the instrumentation also worked perfectly. White paint was used on the outer surface of the probe to control the amount of heat received from the sun and the amount radiated to space. In order to preserve the instrumentation, it was necessary to control the temperature within 10 and 50 degrees Centigrade. Telemetry shows that the temperature reached 43 degrees Centigrade (100 degrees Fahrenheit) shortly after launch and remained at that level throughout the life of the probe.

END